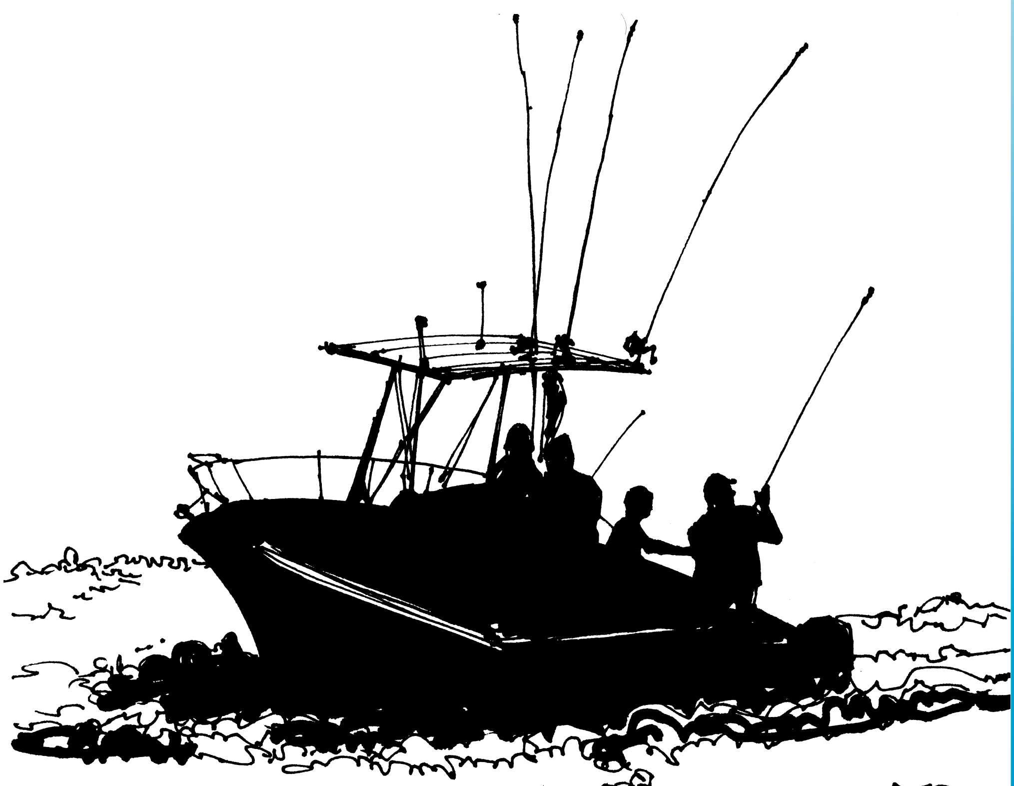
Environmental Consequences of Alternatives



4

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This section describes the predicted impacts to those components of the natural, built, and human environment described in Section 3 (Affected Environment) for each alternative defined in Section 2 (Alternatives Including the Proposed Action). NEPA requires that the analysis of alternatives consider seven types of impacts: direct, indirect, cumulative, short-term, long-term, irreversible and irretrievable (CEQ Regulations at 40 CFR 1508.25; NEPA section 102[2][C][iv][v]). The alternatives analyses in this section focus on the assessment of direct, indirect and cumulative effects.

<u>Direct effects</u> are caused by the action and occur at the same time and place (CEQ Regulations at 40 CFR 1508.8).

<u>Indirect effects</u> are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (CEQ Regulations at 40 CFR 1508.8).

<u>Cumulative impacts</u> result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (CEQ Regulations at 40 CFR 1508.7).

Predicted environmental effects of this nature are described in this section by environmental resource. Given the six-year duration of the Proposed Action, the effects are predicted to be primarily short-term in nature. No irreversible impacts associated with the Proposed Action and alternatives are predicted to occur. Long-term and irretrievable impacts are discussed with direct effects.

In order to evaluate the potential severity of environmental effects, metrics are used to characterize the magnitude and intensity of the effect. The metrics used in this analysis include:

<u>No effect</u>: Not measurable or expected, or of such a rare occurrence that it would be impossible to measure or detect.

<u>Low effect</u>: Measurable but of small amount or infrequent occurrence.

<u>Moderate effect</u>: Measurable at some level between low and substantial.

<u>Substantial effect</u>: A high impact that is measurable and/or expected, or likely to occur more frequently than anticipated.

Predicted environmental effects are quantified where possible, but for several resources where quantifiable information is not available, the analysis relies on qualitative assessments and best professional judgment.

Section 4.2 (following) describes the basis for the comparison of alternatives, and describes the analysis approach. The analyses in this section follow the order of resource issues described in

Section 3, Affected Environment. For example, the fish resource was described in Subsection 3.3, and the alternatives analysis for fish is found in Subsection 4.3. Discussions of the natural, built and human environment are organized as follows:

Section 4 Subsections	Natural Environment	Built Environment	Human Environment
4.3.1 and 4.3.2: Status of salmonid species	X		
4.3.3: Other fishes	X		
4.3.4: Fish habitat	X		
4.3.5 through 4.3.7: Potential ecological effects of alternative harvest activities	X		
4.4: Tribal treaty rights and trust responsibilities			X
4.5: Non-commercial use of salmonids by Puget Sound tribes			X
4.6: Regional economics of commercial and sport fisheries			X
4.7: Environmental justice			X
4.8.1 through 4.8.3 and 4.8.5: Seabirds, marine mammals, and other wildlife species	X		
4.8.4: Lower trophic-level species	X		
4.9: Land ownership and land use		X	
4.10: Water quality	X		

4.2 Basis for Comparison of Alternatives and Approach to Alternatives Analysis

The basis for comparing the alternatives described in Section 2, and the approach to the alternatives analysis is briefly described in this section to introduce the methods for predicting the effects of the Proposed Action and alternatives. Technical modeling tools used to analyze the Proposed Action and alternatives are also described.

4.2.1 No Action Alternative

NEPA essentially asks how current environmental conditions would change with the Proposed Action or alternatives. Therefore, the environmental consequences analysis of the alternatives requires defining a baseline against which the Proposed Action and alternatives can be evaluated and contrasted. In practice, this baseline is usually either existing conditions (i.e., the affected environment), or the no action alternative (CEQ Regulations at 40 CFR 1502.15). However, although NEPA requires that the alternatives considered for detailed analysis include a no action alternative, neither NEPA nor the CEQ implementing regulations require that the no action alternative be used as the baseline.

For this analysis, the Proposed Action (Alternative 1) most closely approximates current baseline conditions, because the same type of chinook salmon harvest management plan has been implemented since 2000. In situations where the proposed activity is fundamentally the continuation of a current management activity, the proposed action may be defined as the no action alternative because the proposed action represents no change from the baseline environmental condition (CEQ 40 Questions, question 3).[i] This may raise some confusion in relation to the settlement agreement with Washington Trout v. Lohn, in which no authorized take of listed chinook in Puget Sound (Alternative 4) is identified as the no action alternative to describe the case where literally no harvest of listed Puget Sound chinook salmon would occur. For the purposes of this analysis, Alternative 1 (the Proposed Action) is the baseline for comparison of alternatives under NEPA, and Alternative 4 represents the case in which the Proposed Action would not occur. The alternatives analyzed in detail in this

[i] CEQ interpreted the 'no action' alternative in two ways (CEQ 40 Questions, question 3):

1) For a continuing action, such as a long-term plan or program of action, 'no action' is defined as 'no change' from current management direction or level of management intensity.
2) For a project, 'no action' is defined as 'the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward."

Fundamentally, these two interpretations are the same since each is intended to define the environmental baseline conditions that exist prior to the implementation of the proposed activity or its alternatives.

Environmental Impact Statement are compared to one another, as required by NEPA, to obtain a clear understanding of the comparative merits of each alternative.

4.2.2 Technical Approach to Impact Assessment

The Affected Environment section of this Environmental Impact Statement (Section 3) describes the effects of fishing that have occurred in the past; however, it does not accurately describe the baseline conditions from which the effects of the Puget Sound chinook salmon harvest alternatives can be determined, due to changing environmental conditions, population abundance and market conditions. Every year, the Washington Department of Fish and Wildlife and the Puget Sound treaty tribes (the co-managers) use a technical model[ii] to evaluate the effects of harvest management regimes against the predicted salmon abundances for the coming year. Therefore, this model could be used to examine the effects of various alternatives on the salmon resource by comparing them under the same set of baseline environmental conditions.

The 2003 fishing year is representative of salmon abundance and fishing patterns in recent years;[iii] therefore, 2003 pre-season expectations and modeling information are used to describe the general pattern of fisheries that would reasonably be expected to occur under Alternative 1, the Proposed Action, over the time period it would be in effect (the ~~2004~~ 2005–2009 fishing seasons). The model was then adjusted from these baseline conditions to predict impacts to salmon for the three harvest management alternatives described in Section 2. This information formed the basis for the alternatives analysis in this Environmental Impact Statement. A detailed description of the modeling assumptions is provided in Appendix C.

The environmental consequences of the Proposed Action and alternatives are affected by the distribution and magnitude of catch or mortality (catch and exploitation rate), available opportunities (sport angler trips), and numbers of fish that remain to reproduce (escapement). For example, the amount of money that comes into a community from fishing depends largely on the amount of fish commercial fishermen catch to sell, the opportunities available to sport fishermen to catch fish, and where those opportunities are available. Predicted effects to Puget Sound tribal treaty rights or subsistence uses are also dependent on access to fish and the available amount of fish. Predicted effects

[ii] The model is called the Fisheries Regulation and Assessment Model (FRAM).

[iii] Pink salmon return to Puget Sound only during odd-numbered years, so 2003 is the most recent year that would include impacts resulting from pink salmon fisheries. Using a year that includes pink salmon fisheries and returning pink salmon adults ensures that impacts to all salmon species are accurately represented.

on fish and wildlife resources are influenced by the encounters of these species with fishing activities and the number of fish that survive to reproduce. The technical model and other sources of available data were used to predict this core set of parameters: catch, exploitation rates, angler trips and escapement.

4.2.3 Scenarios for Alternatives

The outcome of implementing any of the alternatives evaluated in the Environmental Impact Statement as measured by the core set of parameters described above will depend on the Puget Sound chinook salmon abundance available to the fisheries in any individual year, and the amount of Puget Sound chinook harvest taken in Canadian and Alaskan fisheries prior to chinook salmon reaching Puget Sound fisheries. For example, chinook salmon populations are more likely to achieve management objectives at higher abundance and/or lower levels of Canadian/Alaskan fisheries, and therefore, fishing opportunity would be expected to be more widely distributed throughout Puget Sound. At lower abundance and/or high levels of Canadian/Alaskan fisheries, the geographic scope of fisheries and the amount of catch would be expected to be substantially reduced. Therefore, the Environmental Consequences analyses incorporate assumptions about the range of chinook salmon abundances and levels of chinook harvest in Canadian/Alaskan fisheries that could reasonably be expected to occur for the duration of the Proposed Action (the ~~2004~~ 2005–2009 fishing seasons).

These different scenarios are used only to explore the range of possible impacts to chinook salmon. The assumptions regarding the range of abundance and Canadian/Alaskan fisheries for coho, sockeye, pink, chum and steelhead are the same among scenarios for two reasons: 1) the purpose of the Proposed Action is to manage Puget Sound chinook salmon. It does not include management objectives for other species or describe how fisheries will respond to changes in abundance of those other salmon species; and, 2) the 1999 Pacific Salmon Treaty Chinook Annex provides the necessary information to model chinook impacts under higher levels of fishing than those observed in recent years, but which might occur in the next few years. However, there is insufficient information to allow modeling how catch of salmon species other than chinook would vary in response to changes in Canadian/Alaskan fisheries. Therefore, the analysis assumes abundance and Canadian/Alaskan fishery impacts for non-chinook salmon species will remain similar to those experienced in recent years.

4.2.3.1 Abundance

Abundance fluctuates due to changes in survival in the marine and freshwater environments through which salmon pass during their life cycle. Evidence suggests that marine survival of salmon species fluctuates in response to 20 to 30-year cycles of climatic conditions and ocean productivity (Mantua

1997; Cramer 1999). Declines in marine survival began to be detected in the early 1990s so marine survival would be expected to continue to be low for the next 10 to 20 years, although there has been some indication that marine survival has increased in the last several years, resulting in increased abundance of West Coast chinook salmon populations. To look at the level of abundance that might be reasonable to expect over the duration of the Proposed Action (the ~~2004~~ 2005–2009 fishing seasons), the pattern of Puget Sound chinook salmon abundance over the last thirteen years (1991 through 2003) was examined since it included periods of low marine survival (1990s),[iv] and what is believed to be higher marine survival (2000 through 2003). Freshwater conditions have not been found to fluctuate in cycles, but the changes in these environments have contributed to the variation in chinook salmon abundance observed in this same period. Total Puget Sound chinook salmon abundance in the 1990s averaged approximately 30 percent less than abundance observed in recent years,[v] so a 30 percent reduction in Puget Sound chinook abundance from the 2003 predicted Puget Sound chinook abundance was chosen for the low abundance condition. It is possible that marine survival could continue to increase, but there are some indications, based on ocean interceptions of immature Columbia River chinook, that abundance of West Coast salmon may decrease in the next few years (personal communication with D. Simmons, NMFS, February 2, 2004). Therefore, the 2003 abundance was chosen to represent the high abundance condition.

4.2.3.2 Canadian and Alaskan Fisheries

In their ocean migration, Puget Sound chinook salmon travel north along the west coast into Canadian waters, and at times as far north as Alaskan waters (Figure 1.4-1). Depending on the population, Canadian fisheries on average can account for as much as 75 percent of the fishing-related mortality on Puget Sound chinook salmon (see Subsection 4.3.1). Alaskan fisheries harvest a low proportion (1 to 2%) of Puget Sound chinook salmon. Although the management of Canadian fisheries is outside the jurisdiction of the co-managers, the level of Canadian/Alaskan fisheries is an important consideration in assessing the total impact of fishing on Puget Sound chinook salmon populations, and the contribution of Puget Sound fisheries to that total impact.

[iv] Marine survival in the 1990s was the lowest observed since the early 1970s.

[v] Although Puget Sound chinook salmon showed the same general trend in abundance, not all populations showed an increasing trend over the same period, and the variability in abundance varied from population to population.

The major Canadian fisheries that currently or in the past have harvested large numbers of Puget Sound chinook salmon include the West Coast Vancouver Island troll and sport fisheries, the Georgia Strait troll fishery and the Georgia Strait and Canadian Strait of Juan de Fuca sport fisheries. In recent years, Canadian fisheries have not harvested chinook salmon at levels allowed under the Pacific Salmon Treaty due to internal Canadian conservation issues (NMFS 2003). The Georgia Strait troll fishery has been virtually eliminated since 1995 (CTC 2003), and that situation is expected to continue because of changes in Canadian management priorities. Also, many of the fishermen previously in the Georgia Strait troll fishery have sold their fishing gear or moved to other fisheries. However, effort and catches in the other Canadian fisheries have been increasing from the record low levels in the most recent few years (CTC 2003). Fishery restrictions implemented in the mid-1990s to address Canadian chinook and coho salmon conservation concerns are likely to be relaxed to some degree in these fisheries in the next several years and may result in increased fisherman participation and catch. Therefore, the Canadian/Alaskan fisheries regime projected to occur in 2003 was chosen as the low northern fisheries condition because for Canadian fisheries other than the Georgia Strait troll fishery, it is unlikely that Canadian catch levels will decrease from those projected to occur in 2003, and more likely that total effort and catch will continue to increase from 2003 levels.

Maximum harvest levels expected to occur under the Pacific Salmon Treaty during implementation of the 2004–2009 RMP were modeled to represent the upper range of impacts associated with Canadian fisheries (i.e., worst case scenario). These maximum expected levels are not the maximum allowed under the Pacific Salmon Treaty, but the maximum reasonably expected to occur during the ~~2004~~ 2005–2009 fishing seasons, based on recent fishing patterns, shifts in fishing sector allocation over the past 10 years, and discussions with Canadian fishing managers (personal communication with D. Simmons, NMFS, Pat Pattillo, WDFW, and Larrie Lavoy, WDFW, July 2003). The maximum Canadian/Alaskan fisheries expected to occur during the 2004–2009 fishing seasons assumed: 1) the West Coast Vancouver Island troll and sport fishery would occur under the maximum level allowed under the Pacific Salmon Treaty; 2) the Georgia Strait troll fishery would remain at very low levels; and, 3) the Georgia Strait and Canadian Strait of Juan de Fuca sport fisheries would occur at the highest estimated catch level observed for the period 1994–2002. ~~A more detailed discussion of Canadian harvest patterns and the basis of the maximum northern fisheries scenario is included in Appendix B.~~

Taking into account the information on both abundance and expected northern fishing patterns described above, four scenarios were developed by the Interdisciplinary Team that encompass the range of abundance and northern fishing conditions that might reasonably be expected to occur during the implementation of the Proposed Action (Table 4.2-1).

Table 4.2-1. Scenarios associated with estimated harvest levels within the Puget Sound Action Area.

Scenario	Abundance	Alaskan/Canadian Fisheries
Scenario A	2003 Puget Sound abundance	2003 Canadian/Alaskan fisheries harvest
Scenario B	**2003 Puget Sound abundance**	**high Canadian/Alaskan fisheries harvest**
Scenario C	30% reduction from 2003 abundance	2003 Canadian/Alaskan fisheries harvest
Scenario D	30% reduction from 2003 abundance	high Alaskan/Canadian fisheries harvest.

The indications of a plateau or potential reduction in marine survival and expectations that Canadian fisheries will continue to increase as they have in recent years led the Interdisciplinary Team to conclude that Scenario B is the *most likely* to occur during the implementation of the Proposed Action. Consequently, the assessment of environmental consequences in the following subsections focus on comparisons to this alternative. The results under Scenarios A, C, or D are also reported, but in less detail.

4.3 Fish

4.3.1 Threatened and Endangered Fish Species

This section discusses the predicted, direct, environmental consequences of the Proposed Action or alternatives with respect to listed salmonid species found within the action area: Puget Sound chinook salmon, Hood Canal summer chum salmon, bull trout, Columbia River chinook salmon, and Columbia River chum salmon. The following discussion will address these species in this order. Indirect and cumulative impacts are discussed in Section 4.3.8.

Puget Sound Chinook and Hood Canal Summer Chum

Standards of Comparison for Puget Sound Chinook

The Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU) was listed as threatened in 1999 because the potential for these populations to become endangered in the foreseeable future was believed to be high if current conditions continued (Meyer et al. 1998). Harvest is identified as one factor of decline in the listing decision. The co-managers anticipate the vast majority of the harvest-related mortality to listed Puget Sound chinook salmon over the duration of the Resource Management Plan (RMP) will be incidental to fisheries directed at other stocks or species (~~NMFS 2004~~WDFW and PSIT 2004~~ [4(d) determination]~~). Nevertheless, over the past decade, the co-managers have constrained harvest mortality, severely for some populations in the ESU, to avoid escapement falling to the point of instability. These harvest reductions have been in response to significant reductions in productivity and capacity of chinook salmon-bearing watersheds throughout Puget Sound, largely as a result of habitat degradation. The National Marine Fisheries Service (NMFS) has found these harvest actions are consistent with the requirements of the Endangered Species Act (ESA) (NMFS 1999; NMFS 2001; NMFS 2003; Puget Sound Treaty Tribes and Washington Department of Fish and Wildlife 2003).

The potential impacts of the Proposed Action or alternatives on listed Puget Sound chinook salmon are quantified in terms of the projected total fisheries exploitation rate and resulting spawning escapement for each population. In general terms, *exploitation rate* is the number of fish harvested from each population divided by the number of fish in the population[vi] (see Appendix C). *Spawning escapement* is the estimated number of fish that return to the spawning grounds each year. For some populations,

[vi] The total exploitation rate is technically defined as the proportion of adult chinook, from all year-classes, prior to the onset of fishing in a given year, harvested or killed incidentally as a result of fishing.

spawning escapement is measured in terms of those fish whose parents spawned naturally rather than in hatcheries or by other artificial propagation means.

Survival and recovery of the Puget Sound Chinook ESU will depend, over the long term, on necessary actions in other sectors, especially habitat actions, and not on harvest actions alone. There is an ongoing recovery planning effort for the Puget Sound Chinook ESU. Completion of the recovery plan and decisions regarding the form and timing of recovery efforts described in the recovery plan will determine the kinds of harvest actions that may be necessary and appropriate in the future. Absent that guidance at the time of this writing, NMFS must evaluate the proposed harvest actions by examining the impacts of harvest within the current context. Therefore, NMFS has evaluated the future performance of populations in the ESU under recent productivity conditions; i.e., assuming that the impact of hatchery and habitat management actions remain as they are now. The actual performance of the populations will vary due natural variability in freshwater and marine survival, and may also vary due to actions in the habitat and hatchery sectors. For example, if habitat and hatchery actions improve conditions over currently existing conditions, the current NMFS conservation standards would be conservative, likely overestimating the impact that harvest actions would have on the ESU.

Where available, exploitation rates and spawning escapement are compared to population-specific conservation standards established by the NMFS to ascertain whether fisheries will appreciably reduce survival and recovery of the ESU, as required by the ESA 4(d) Rule. Conservation standards are represented by rebuilding exploitation rates, critical escapement thresholds, and viable escapement thresholds.

The rebuilding exploitation rates (RERs) represent the highest rate of harvest that will achieve the following ESA conservation criteria. Over the long term (25 years), harvest at the RER level will achieve: 1a) a high (80%) probability of rebuilding, or 1b) no more than a 10 percent reduction in the probability of rebuilding, and 2) a very low (5%) probability of the population falling to the critical threshold (see Appendix A) compared with a zero-harvest baseline. Fishing regimes that exert harvest rates below the RER level, by definition, do not pose jeopardy to the ESU. Fishing regimes above the RERs may also not pose jeopardy to the ESU depending on the status and distribution of the chinook salmon populations throughout the ESU.

The *critical escapement threshold* (CET) represents a point of biological instability, below which the risk of extinction increases significantly, due to declining spawning success, depensatory mortality, or risk of loss of genetic integrity. This threshold is not precisely known for any population, but may be estimated by risk assessment if the current productivity of a population can be estimated. Based on theoretical assessment of ecological and genetic risk (McElhaney et al. 2000; and NMFS 2001), a generic critical threshold of 200 adults has been used for other populations for which population-specific data are unavailable or insufficient to estimate productivity. *Viable escapement thresholds* (VETs) in the context of this EIS analysis are a level of spawning escapement associated with rebuilding to recovery, consistent with current environmental conditions. For most populations, these thresholds are well below the escapement levels associated with recovery, but achieving these goals under current conditions is a necessary step to eventual recovery when habitat and other conditions are more favorable. Where data are available, viable escapement thresholds have been defined consistent with the current productivity and capacity of spawning habitat. Where such information is not available, the generic viable threshold (1,250 adults) defined by NMFS for Viable Salmonid Populations (McElhany et al. 2000; NMFS 2001) is used as a reference point. By definition, these thresholds offer only general guidance as to what generally represents points of stability or instability. Some populations may be fairly robust at very low abundances, while chinook salmon populations in large river systems may become unstable at higher abundances depending on resource location and spawner density. However, without population-specific information, NMFS believes these generic guidelines offer the best available information.

NMFS has developed specific conservation standards for 12 of the 22 populations and one management unit (Nooksack early) within the Puget Sound Chinook ESU (Table 4.3-1). Nine of these 12 populations and one management unit have estimates of rebuilding exploitation rate (RER), critical escapement threshold (CET), and viable escapement threshold (VET). Although RERs have not been established for the Upper Cascade spring or Snoqualmie chinook populations, ancillary information indicated that the RERs developed for other populations within their management units should be protective of these populations (Susan Bishop, NMFS, April 20, 2003; and Skagit Rebuilding Exploitation Rate Workgroup 2003). The remaining populations have a mixture of specific and generic standards – also developed by NMFS (McElhany et al. 2000). Standards for all populations are summarized in Table4.3-1. NMFS uses all of this information to assess the status and distribution of the chinook salmon populations throughout the ESU, and then to determine whether the harvest action would pose jeopardy to the ESU as a whole.

The model used for this EIS analysis estimated fishery impacts to chinook salmon and other species in Alaska, British Columbia, and *Southern U.S. Fisheries* – those occurring in Puget Sound and off the Pacific coast of Washington, Oregon, and California (see Technical Appendix B). Within the Southern

U.S. area, more than 95 percent of the catch of species discussed here occurs within Puget Sound (Pacific Salmon Commission 2002).

Subsection 4.3.1 compares the impacts of the Proposed Action or alternatives on Puget Sound chinook under each of four scenarios as described in Subsection 4.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. Each scenario defines a different baseline condition in terms of forecast abundance of Puget Sound Chinook and harvests occurring in fisheries in Canada and Alaska.

These different scenarios are used only to explore the range of possible impacts to chinook salmon. The assumptions regarding the range of abundance and Canadian/Alaskan fisheries for coho, sockeye, pink, chum, and steelhead are the same among scenarios for two reasons: 1) the purpose of the Proposed Action is to manage Puget Sound chinook salmon. It does not include management objectives for other species or describe how fisheries will respond to changes in abundance of those other salmon species; and 2) the 1999 Pacific Salmon Treaty Chinook Annex provides the necessary information to model chinook salmon impacts under higher levels of fishing than those observed in recent years, but which might occur in the next few years. However, there is insufficient information to allow NMFS to model how catch of salmon species other than chinook would vary in response to changes in Canadian/Alaskan fisheries. Therefore, the analysis assumes abundance and Canadian/Alaskan fishery impacts for non-chinook salmon species will remain similar to those experienced in recent years.

Table 4.3-1. Rebuilding Exploitation Rates, and critical and viable escapement standards for listed Puget Sound chinook and Hood Canal summer chum, against which impacts of Alternatives were assessed.

Population	Rebuilding Exploitation Rate	Critical escapement	MSY, viable, or capacity escapement level
Nooksack Spring	12%		500
North Fork		200	
South Fork		200	
Skagit Summer-Fall			
Lower Skagit	49%	251	2182
Lower Sauk	51%	200	681
Upper Skagit	60%	967	7454
Skagit Spring			
Upper Cascade		170	
Upper Sauk	38%	130	330
Suiattle	41%	170	400
Stillaguamish Summer-Fall			
North Fork	32%	300	552
South Fork	24%	200	300
Snohomish Summer-Fall	18%		
Skykomish	18%	1650	3500
Snoqualmie		400	
Green	53%	835	5523
Lake Washington			
Sammamish		200	1200
Cedar		200	1200
Puyallup		200	1200
White River Spring		200	1000
Nisqually		200	1100
Mid- Hood Canal / Dosewallips		200	1250
Skokomish		200	1250
Dungeness		200	925
Elwha		200	2900
Hood Canal – Juan de Fuca Summer Chum Populations			
Hood Canal	11%	4070	
Strait of Juan de Fuca	9%	920	

Scenario	Pre-Action Resource Status [vii]	
	Abundance	Harvest in Canadian/Alaskan Fisheries
Scenario A	2003	2003
Scenario B	2003	Maximum expected under the 1999-2008 Pacific Salmon Treaty Annex
Scenario C	70% of 2003	2003
Scenario D	70% of 2003	Maximum expected under the 1999-2008 Pacific Salmon Treaty Annex

Scenario B is considered the most likely scenario during the RMP implementation period; therefore, the analysis emphasizes this scenario. However, the performance of each alternative is compared both across the four scenarios, and with each of the other alternatives for a given scenario. For example, Alternative 2 is evaluated for Scenarios A through D. Then Alternative 2, Scenario A is compared with Alternative 1, Scenario A, and so forth.

Table 4.3-3 in Subsection 4.3.1.5, Summary Discussion of Alternatives, summarizes the performance of each alternative (under Scenario B) in relation to the conservation standards for those populations. Table 4.3-4 in Subsection 4.3.1.5 summarizes the impacts of Alternatives 2 through 4 relative to Alternative 1, the Proposed Action, under Scenario B. Table 4.3-5 in Subsection 4.3.1.5 summarizes performance of each alternative under all scenarios relative to conservation standards, and Table 4.3.6 summarizes impacts of Alternatives 2 though 4 for all scenarios. Additional tables in this Subsection 4.3.1.5 (and in Appendix B) provide more detailed information on exploitation rates, total fishery-related mortality for hatchery and natural chinook salmon (landed and non-landed), and escapement of hatchery and naturally-spawning chinook salmon.

<u>Standards of Comparison for Hood Canal Summer Chum</u>

There are seven summer chum salmon populations in the listed Hood Canal-Strait of Juan de Fuca summer chum ESU. NMFS has determined that over the long term, fisheries exploitation rates should be constrained to an average of 10.9 percent or less for Hood Canal component salmon and 9 percent or less for Strait of Juan de Fuca component of the Hood Canal/Strait of Juan de Fuca ESU. This standard

[vii] Represents preseason projections of 2003 fisheries and abundance.

allows that, in any one year, exploitation rates may vary from 3 to 15 percent for the Hood Canal component, and from 3 to 12 percent for the Strait of Juan de Fuca component. Fisheries should result in appropriate distribution of escapement among the various populations in each region, and should not otherwise impede the survival and recovery of the ESU (NMFS 2000). For summer chum, exploitation rates are expressed as total catch (in all fisheries) as a proportion of the sum of catch and escapement. However~~, returns to the Quilcene River~~ Quilcene summer-chum stock (Quilcene/Dabob Bay Management Unit) (for which the run is dominated by a large summer chum hatchery program) are excluded from the exploitation rate calculation. Critical escapement goals have also been designated: 4,070 for the Hood Canal summer chum region, and 920 for the Strait of Juan de Fuca region.

Bull Trout, and Columbia River Chinook and Chum Salmon

A small number of anadromous char, presumed to be bull trout, are caught in freshwater sport fisheries and may be caught in near-shore salmon net fisheries primarily in northern Puget Sound. Listed Columbia River-origin chinook and chum salmon are infrequently caught in Puget Sound (personal communication via e-mail from Dell Simmons, NMFS, to Susan Bishop, NMFS Sustainable Fisheries Division, December 2002).

Fishery closures under Alternative 2, 3 or 4 would slightly reduce the rare catch of these species that might occur under Alternative 1, but neither the Proposed Action nor the Alternatives would exert a measurable impact on these species under any of the harvest management scenarios. Therefore, bull trout and the Columbia River ESUs will not be discussed further in this document.

Metrics for Comparison of Impacts

The Proposed Action (Alternative 1) serves as the baseline against which the other alternatives are measured. The magnitude of the impacts of Alternatives 2, 3, or 4 relative to the baseline are classified as follows:

Term	When the impact varies by:
None	Not measurable, rare, infrequent
Low	Less than 10 percent
Moderate	10 percent to 30 percent
Substantial	More than 30 percent

Although it is useful and necessary to provide some system of metrics against which to assess the effects of the Proposed Action or alternatives, the complexity of salmon life history means that the magnitude of changes in effect may not translate into realized benefits or risks to the populations of the same magnitude. Therefore, it is important to note that there are several limitations to the application of these metrics to fish that should be taken into account in interpreting the results of applying these metrics. First, substantial increases in spawning escapements may not result in commensurate increases in the progeny of those spawners. The objective for salmon fisheries management is to constrain fishing mortality to the extent necessary to optimize the production of subsequent generations. The *productivity* of salmon populations, often defined in terms of the number of recruits produced per female spawner, increases over a range of escapement, then reaches a plateau or declines at higher levels of escapement due to density-dependent survival; i.e., too many spawners for the available habitat, or too many juvenile salmon for the available food in the river. The escapement level corresponding to the point of optimum productivity varies widely among individual populations due to the accessible area of suitable spawning and rearing habitat within a river system, and the very complex array of physical and biological factors that influence the annual survival of salmon eggs and juveniles through their freshwater life history. However, the influence of these physical and biological factors varies greatly from year to year, so that were fisheries management to achieve optimum escapement consistently from year to year, the actual production from those spawners would still vary widely. The marine environment exerts even greater influence on the number of juvenile salmon that reach adulthood. Consequently, this Environmental Impact Statement can compare the predicted escapement for populations against specific or general escapement standards, but cannot accurately project the resulting abundance of subsequent generations of adult salmon. Also, changes in risk relative to achievement of the Rebuilding Exploitation Rates may not be the same as changes in risk measured by changes in escapement. That is, the changes in achieving the Rebuilding Exploitation Rates are likely to be more beneficial or adverse relative to recovery than changes in escapement.

It should also be noted that changes in exploitation rates are expressed in the discussion below as the difference – in percentage points – between two rates, whereas changes in escapement are expressed as the percent difference between two values. For example, if the exploitation rate for Nooksack early chinook is 20 percent under Alternative 1 and 15 percent under Alternative 2, the change is 5 percentage points (20% minus 15% = 5%). If the escapement of Nooksack early chinook changes from 200 under Alternative 1 to 250 under Alternative 2, the change is 25 percent ([250 minus 200] divided by 200).

4.3.1.1 Alternative 1 – Proposed Action/Status Quo

Alternative 1 (the Proposed Action) is the alternative that most closely resembles recent historical harvest management plans. Its implementation is predicted to result in exploitation rates below rebuilding exploitation rate (RER) ceilings for five of the nine populations and one management unit that have RER standards. With the exception of the Nooksack early management unit, escapements under this alternative are predicted to exceed critical thresholds for all populations under all scenarios, in most cases by substantial margins. Viable escapement thresholds (VETs) are predicted to be met or exceeded for nine of the 18 populations and one management unit that have VET standards.

Summary of Scenario Differences

Under Alternative 1, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries (D), the predicted Southern U.S. catch from listed Puget Sound populations is 106 percent, 74 percent, and 71 percent respectively of that under Scenario B (see Table 4.3-2 in Subsection 4.3.1.5, Summary Discussion of Alternatives). Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

Exploitation rates under Alternative 1, Scenarios A, C, and D are predicted to vary from those under Alternative 1, Scenario B, by 1 to 5 percent. Exploitation rates for the Nooksack population, which exceeded RER ceilings under Alternative 1, Scenario B, also are predicted to exceed RER ceilings under Scenarios A, C, or D by margins of 8 to 14 percent. Exploitation rates for the Skykomish River chinook salmon population are also predicted to exceed the RER ceiling under all scenarios by margins of 1 percent to 5 percent. Exploitation rates for the Lower Skagit River fall and Lower Sauk River summer chinook populations, which were not predicted to meet RER ceilings under Alternative 1, Scenario B, were below the ceiling under Alternative 1, Scenarios A or C, by 1 to 3 percent, and above the RER ceiling under Scenario D by 5 to 7 percent. The exploitation rate for the Green River fall chinook population is predicted to exceed the RER ceiling under Alternative 1, Scenario A, by 9 percent, but is predicted to be 4 to 5 percent below the ceiling under Scenarios C or D (see Table 4.3-5 and Table 4.3-7a through Table 4.3-7d in Subsection 4.3.1.5).

Except for the Nooksack early populations, all populations that met CETs under Alternative 1, Scenario B, are predicted to meet them under Scenarios B, C, or D, as well. The North Fork Nooksack River early chinook salmon population is not predicted to meet CETs in any scenario under Alternative 1. The South Fork Nooksack population is not predicted to meet its CET under Scenarios C or D. The Upper Skagit River summer chinook population, which was predicted to meet its VET goal under Alternative 1, Scenario B, was also predicted to meet it under Alternative 1, Scenario A, but to fall slightly below goal under Alternative 1, Scenarios C or D. This was also true for the South Fork Stillaguamish fall population. Other populations that would meet or exceed VET goals under Scenario

B would meet or exceed them under the other scenarios, and those that were predicted to fall below goal under Scenario B also did so under the other scenarios (see Table 4.3-5 in Subsection 4.3.1.5).

Impacts to Puget Sound Chinook Populations

Under Alternative 1, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the fishery model projected Southern U.S. catches of 52,720 chinook from naturally-spawning Puget Sound populations, and 1,663 chum from listed Hood Canal/Strait of Juan de Fuca summer populations. An additional 81,570 chinook from hatcheries and streams outside the action area are predicted to be caught (see Table 4.3-2 in Subsection 4.3.1.5).

Under Alternative 1, Scenario B, exploitation rates are predicted to be below their RERs for five of the nine populations and one management unit for which RERs have been derived (see Table 4.3-3 in Subsection 4.3.1.5). Exploitation rates are predicted by the fisheries model to exceed RER standards for the Nooksack early management unit by 13 percentage points, despite the fact that the Southern U.S. exploitation rate is predicted to be only 7 percentage points. The Lower Skagit River population is predicted to exceed its RER ceiling by 6 percentage points, the Lower Sauk River population by 4 percentage points, the Skykomish River population by 4 percentage points, and the Green River chinook salmon population by 10 percentage points. However, owing to peculiarities associated with the 2003 base year data for the Skagit summer/fall chinook salmon populations, it is likely that the model predicts higher exploitation rates than may actually occur [viii] during implementation of the Proposed Action (NMFS 2004 [4(d) determination]). It is also important to note that for the Skagit River summer-fall chinook populations, the predicted Southern U.S. exploitation rate (16%) accounted for less than one-fourth of the total predicted exploitation rate (55%) (see Table 4.3-3 and detail Table 4.3-7b in Subsection 4.3.1.5). The model predicted that exploitation rates for six populations would fall below RER ceilings under Alternative 1, Scenario B, by margins of 5 to 13 percentage points. These include exploitation rates for the upper Skagit, Upper Sauk and Suiattle chinook populations (11% and 14%, respectively, below the RER ceiling), the North Fork Stillaguamish and the South Fork Stillaguamish chinook populations (13% and 5%, respectively, below the RER ceiling) (see Table 4.3-7b in Subsection 4.3.1.5). The model predicted that, under Alternative 1, Scenario A, exploitation rates

[viii] Anomalous age structure and the presence of pink salmon fisheries in 2003 make the estimates of exploitation rates liberal, The Southern United States exploitation rates are more likely to be similar to recent years; i.e., 6 to 18 percent

for two additional populations – the lower Skagit fall and Lower Sauk summer populations – would fall below their RER ceilings (1% and 3%, respectively) (see Table 4.3-7a in Subsection 4.3.1.5).

The majority of harvest for the Nooksack early and Skagit summer/fall occurs in Canadian fisheries. The RER for the Nooksack early chinook management unit is predicted to be exceeded even without Southern U.S. fishing. For the Nooksack early chinook management unit, harvest mortality in Southern U.S. fisheries is predicted to increase the probability of falling below its CET by 21 percentage points and decrease the probability of rebuilding by 6 percentage points, measured over 25 years. For the Skagit summer/fall chinook salmon populations, harvest mortality in Southern U.S. fisheries is predicted to keep the probability of falling below its CET below 5 percentage points and decrease the probability of rebuilding by 26 percentage points, measured over 25 years. It should be noted that these are probably maximum estimates since the calculations are based on low marine survival assumptions, and recent information indicates that marine survival may be improving. Both the Skagit River summer/fall populations are currently above their VETs and have shown increasing trends in escapement.

Under Alternative 1, Scenario B, only the North Fork Nooksack chinook salmon population is predicted to not meet its CET. For most other populations, escapements are predicted to exceed critical thresholds by more than 100 percent. Escapement is predicted to exceed the viable escapement threshold for nine populations, including: Upper Skagit River, Upper Sauk River, Suiattle River, North Fork Stillaguamish and South Fork Stillaguamish, Green River, White River, Puyallup River, and Nisqually River. Escapement under Alternative 1, Scenario B, is predicted to be below the VET for 10 chinook populations and one management unit, including: Nooksack River early, Lower Skagit River, Lower Sauk River, Skykomish River, Sammamish River, Cedar River, Mid-Hood Canal, Skokomish, Dungeness, and Elwha chinook salmon populations (see Table 4.3-3 in Subsection 4.3.1.5).

In summary, implementation of Alternative 1 (the Proposed Action), Scenario B, is predicted to result in exploitation rates below RER ceilings for five of the nine populations and one management unit with RER standards. Critical escapement thresholds are predicted to be exceeded for all populations except the Nooksack early management unit, in most cases by substantial margins. Viable escapement thresholds are predicted to be met or exceeded for nine of the 18 populations and one management unit with thresholds, including Upper Skagit; Upper Sauk and Suiattle, North Fork and South Fork Stillaguamish, Green River, Puyallup, White, and Nisqually River chinook salmon populations (see Table 4.3-5 and Tables 4.3-7a through 4.3-7d in Subsection 4.3.1.5).

The Puget Sound Technical Recovery Team (TRT) has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 1, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; five of the eight [ix] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia, Hood Canal, or Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

NMFS is currently evaluating Alternative 1, as proposed by the co-managers in the Puget Sound Chinook Management Plan, under the ESA 4(d) Rule. Taking into account the distribution of population status throughout the ESU and other relevant factors, NMFS has preliminarily concluded that Alternative 1 would not appreciably reduce the likelihood of survival and recovery of the ESU (NMFS 2004~~*in press*~~).

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum

The fisheries modeled under Alternative 1 (the Proposed Action) are predicted to result in a Southern U.S. catch of ~~141~~ 1,651 Hood Canal and 12 Strait of Juan de Fuca summer chum salmon (excluding those from the Quilcene/Dabob Bay management unit.~~,~~ However, the majority of the Hood Canal summer chum catch is comprised of fish from the Quilcene/Dabob Bay Management Unit, which are managed for an escapement goal and treated separately under the Summer Chum Salmon Conservation Initiative). Escapement in this management unit is dominated by production from the Big Quilcene hatchery. Excluding the Quilcene/Dabob Bay Management Unit harvest, the Southern U.S. catch of Hood Canal summer chum is expected to be 214 and ~~T~~the exploitation rates (including Canadian catch) are predicted to be 3~~2~~ percent for the Hood Canal region and 0.4 percent for the Strait of Juan de Fuca region, well below the long-term goals of the Summer Chum Salmon Conservation Initiative of 10.9 percent for Hood Canal summer and 9 percent for Strait of Juan de Fuca summer chum (Washington Department of Fish and Wildlife and Point-No-Point Treaty Tribes, Summer Chum Salmon

---

[ix] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

Conservation Initiative, April 2000). The predicted escapement of ~~11,454~~ 7,437 Hood Canal summer chum (11,454 including the Quilcene/Dabob Bay Management Unit) and 6,955 Strait of Juan de Fuca summer chum exceeds the critical escapement goals for these regions by ~~181~~ 83 percent and 656 percent, respectively (see Table 4.3-7a in Subsection 4.3.1.5).

4.3.1.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Alternative 2 represents a more restrictive fishing regime than Alternative 1, especially for populations in North Puget Sound. With three notable exceptions (discussed below), escapements are predicted to be higher for most populations compared to Alternative 1.

Summary of Scenario Differences

Under Alternative 2, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Alaskan and Canadian fisheries (D), Southern U.S. catch of naturally-spawning chinook salmon is predicted to be 123 percent, 71 percent, and 69 percent respectively of that under Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

Exploitation rates for the Nooksack early chinook management unit, the North Fork Stillaguamish population, and the South Fork Stillaguamish population, which are predicted to exceed RER ceilings under Alternative 2, Scenario B, are also predicted to exceed RER ceilings under Scenarios A, C, or D. Exploitation rates for the Skykomish River and Green River populations are predicted to exceed the RER ceilings under Scenarios A or B, but are predicted to be below the RER ceilings for Scenarios C or D. Escapements for Alternative 2, Scenario A, are predicted to be generally lower than escapements under Alternative 2, Scenario B and escapements under Alternative 2, Scenarios C or D are predicted to be generally higher (see Table 4.3-5 and Tables 4.3-8a through 4.3-8d in Subsection 4.3.1.5). Nevertheless, populations (other than the Nooksack River population) predicted to meet CETs under Scenario B are also predicted to meet CETs under Scenarios A, C, or D, as well. The South Fork Stillaguamish population is not predicted to meet its CET in any scenario under Alternative 2. Populations predicted to meet or exceed VET goals under Alternative 2, Scenario B, are also predicted to meet or exceed them under Alternative 2, Scenario A. With one exception, (Lower Sauk River), populations predicted to meet or exceed VETs under Alternative 2, Scenario B, would meet or exceed VETs under Alternative 2, Scenarios C or D (see Table 4.3-5 and Tables 4.3-8a through 4.3-8d in Subsection 4.3.1.5).

Comparison of Alternative 2 (Escapement Goal Management at the Management Unit Level) to the Proposed Action

Impacts to Puget Sound Chinook Populations

Under Alternative 2, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the fishery model projected Southern U.S. catches of 42,793 chinook from naturally-spawning chinook Puget Sound chinook populations, or 11,743 fewer than with Alternative 1, Scenario B. It is predicted that an additional 36,074 chinook salmon from hatcheries and from streams outside the action area would be caught, which is 75,857 fewer than under Alternative 1, Scenario B (see Table 4.3-2 in Subsection 4.3.1.5).

Under Alternative 2, Scenario B, the total exploitation rate for the Nooksack early management unit is predicted to exceed its RER ceiling by 7 percentage points, despite the fact that the Southern U.S. exploitation rate is predicted to be only 1 percent. The exploitation rate for the North Fork Stillaguamish population is predicted to exceed the RER ceiling by 35 percentage points, the South Fork Stillaguamish population by 43 percentage points, the Skykomish River population by 5 percentage points, and the Green River population by 3 percentage points. Modeled exploitation rates for the five other populations with RERs range from 8 to 25 percentage points less than their RER ceilings. Escapements under Alternative 2, Scenario B, are predicted to exceed the CET for all populations except the North Fork Nooksack and South Fork Stillaguamish populations. In all but five cases (South Fork Nooksack, Skykomish, Sammamish, Cedar and Dungeness populations), escapements are predicted to exceed critical thresholds by more than 100 percent. Escapement under Alternative 2, Scenario B is predicted to meet or exceed VET for 9 of the 18 populations and one management unit for which VETs have been established, including: the Lower Sauk River, Upper Skagit River, Upper Sauk River, Suiattle River, White River, North Fork Stillaguamish, Green-Duwamish, Puyallup River and Nisqually River populations. Modeling results indicate that viable escapement thresholds would not be met for the 10 other populations and one management unit with Alternative 2, Scenario B (see Table 4.3-3 and Table 4.3-8b in Subsection 4.3.1.5).

For the Nooksack early management unit, model results indicate that the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point, and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Relative to Alternative 1, Scenario B, implementing Alternative 2, Scenario B, is predicted to result in low to moderate reductions in exploitation rates for nine Puget Sound chinook populations and one management unit, with resulting increases in spawning escapement. Impacts to these populations would be classed as beneficial and of low to moderate magnitude. Under Alternative 2, Scenario B, chinook salmon spawning escapements are predicted to decrease in the North and South Forks of the Stillaguamish, the Skykomish and Snoqualmie Rivers, and in the Puyallup, White and Nisqually Rivers. Impacts are predicted to be substantially negative for the North Fork Stillaguamish, the South Fork Stillaguamish, the Puyallup and the White River populations. Impacts to populations in the Skykomish, Snoqualmie and Nisqually Rivers are predicted to be negative but low. For the South Fork Stillaguamish population, the decreased escapements are predicted to be approximately 32 percent below the VET. Despite the predicted decrease in spawning escapement in the Puyallup, White, and Nisqually Rivers, these populations are all expected to meet or exceed VETs under Alternative 2, Scenario B. Escapements for the Green, Sammamish, Cedar, and Skokomish River populations are predicted to change by less than 1 percent relative to Alternative 1, Scenario B. These impacts are considered immeasurable. The pattern of impacts from applying Alternative 2 under Scenarios A, C, or D is predicted to be similar to its application under Alternative 2, Scenario B. In most cases, the type of impact (beneficial or negative) under Alternative 2, Scenario B, would be the same under Scenarios A, C, or D. However, as can be seen from Table 4.3-6 in Subsection 4.3.1.5, there is a tendency for the magnitude of beneficial impacts to increase and negative impacts to decrease going from Scenario B to Scenarios C or D. See Tables 4.3-8a-1 and 4.3-8d-2 in Subsection 4.3.1.5 for additional detail.

In summary, because Alternative 2 represents a more restrictive fishing regime than Alternative 1 (especially for populations in North Puget Sound), escapements are predicted to be higher for most populations compared to Alternative 1, Scenario B (see Tables 4.3-4 through 4.3-6 in Subsection 4.3.1.5). The notable exceptions are predicted to be escapements to the North and South Fork Stillaguamish, the Skykomish, and Snoqualmie populations where exploitation rates are predicted to be higher and escapements lower than under Alternative 1, Scenario B. The increased exploitation would result from the additional harvest opportunity available in Tulalip Bay (Marine Catch Area 8D) and the Stillaguamish River under Alternative 2 that is not anticipated to occur under Alternative 1.

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon Evolutionarily Significant Unit: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 2, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; six of the eight[x] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia, Hood Canal, or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack (Strait of Georgia) and South Fork Stillaguamish (North Puget Sound) chinook populations, all populations in all regions are predicted to exceed their CETs.

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum Salmon

Because virtually all marine salmon fisheries would be closed under Alternative 2, incidental impacts to summer chum predicted to occur under Alternative 1 would be eliminated, and the Southern U.S. catch of Hood Canal and Strait of Juan de Fuca summer chum salmon is predicted to be zero. Consequently, the exploitation rate is predicted to decrease to less than 1 percent (including Canadian fishery impacts), and escapement increase by approximatel~~y 76~~ 3 percent. The exploitation rate standards – 10.9 percent for populations in the Hood Canal region, and 9 percent for populations in the Strait of Juan de Fuca region – are predicted to be achieved. The changes in exploitation rate and escapement would be classified as~~ a substantial~~ low, beneficial effect for Hood Canal summer chum. The impact on Strait of Juan de Fuca summer chum is expected to be immeasurable. Impacts under Alternative 2, Scenarios A, C, and D were the same as under Alternative 2, Scenario B (see Tables 4.3-8a and 4.3.8b in Subsection 4.3.1.5).

4.3.1.3 Alternative 3 – Escapement Goal Management at the Population Level

Alternative 3 represents a more restrictive fishing regime than Alternative 1 or Alternative 2, especially for populations in North Puget Sound. Escapements in North Puget Sound watersheds are predicted to be higher under Alternative 3 compared to Alternative 1. For all but two South Puget Sound chinook salmon populations (Puyallup River and White River), changes relative to Alterative 1 are predicted to be minimal.

Summary of Scenario Differences

Under Alternative 3, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries

[x] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

(D), Southern U.S. catch of naturally-spawning Puget Sound chinook salmon is predicted to be 107 percent, 53 percent, and 49 percent, respectively, of that under Alternative 3, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis.

It is predicted that critical escapement thresholds would be met for all populations except the North Fork Nooksack chinook population under Alternative 3, Scenario A. Under Alternative 3, Scenarios C or D, it is predicted that CETs would be met for all populations except the Nooksack early chinook population. With the exception of the Lower Sauk population (20 to 25% below VET under Scenarios C or D), it is predicted that VETs would be met for the same populations under Alternative 3, Scenarios A, C, or D as they were under Alternative 3, Scenario B (see Table 4.3-5 and Tables 4.3-9a through 4.3-9d in Subsection 4.3.1.5).

Comparison of Alternative 3 to Alternative 1 (Proposed Action)

Impacts to Puget Sound Chinook Populations

Under Alternative 3, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the Southern U.S. catch of chinook salmon from naturally-spawning Puget Sound populations is predicted to be 39,231, or 6,018 fewer than with Alternative 1, Scenario B. An additional 30,201 chinook salmon from hatcheries and from streams outside the action area are predicted to be landed, which is 81,730 fewer than with Alternative 1, Scenario B. The catch of listed Hood Canal/Strait of Juan de Fuca summer chum (excluding those from the Quilcene/Dabob Bay Management Unit) is predicted to be zero, or ~~1,663~~ 214 fewer than with Alternative 1, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. See Table 4.3-9a through 4.3-9d in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook~~ and Hood Canal summer chum salmon~~.

Under Alternative 3, Scenario B, RERs are predicted to be met except for the Nooksack early chinook management unit and the Green River chinook population, and in these cases, exploitation rates are predicted to exceed the RER ceilings by 7 percentage points and 3 percentage points, respectively. As with Alternative 2, it should be noted that the Southern U.S. exploitation rate for the Nooksack early management unit is predicted to be only 1 percent while the total exploitation rate is predicted to be 19 percent. For the other populations in this group, predicted exploitation rates range from 8 to 25 percentage points below the RER ceilings. Critical escapement thresholds are predicted to be exceeded for all populations except the North Fork Nooksack population, in most cases by margins well over 100 percent. Escapements are predicted to exceed VETs for ten populations. Notably, the VET for the South Fork Stillaguamish population is predicted to be met with Alternative 3, Scenario B, whereas it is not under Alternative 2, Scenario B. Those populations that are not predicted to exceed VETs under Alternative 3, Scenario B, include Nooksack early, Lower Skagit, Skykomish, Dungeness, Elwha, Sammamish, Cedar, Mid-Hood Canal, and Skokomish chinook salmon populations (see Table 4.3-5 and Tables 4.3-9a-1 through 4.3-9d-2 in Subsection 4.3.1.5).

For the Nooksack early management unit, model results predict that the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point, and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Because Alternative 3 is very similar to Alternative 2, the impacts of its implementation relative to Alternative 1 would be nearly identical to those described for Alternative 2 (see Tables 4.3-3 and 4.3-4 in Subsection 4.3.1.5). The notable exception would be in the Stillaguamish watershed, where application of Alternative 3 is predicted to result in a small reduction in exploitation rate and low beneficial impacts to spawning escapement for populations within the Stillaguamish and Snohomish management units. Under Alternative 3, the South Fork Stillaguamish population is predicted to meet its CET under all scenarios, whereas it is not predicted to meet its CET under Alternative 2 for any scenario. Relative to Alternative 1, Scenario B, impacts associated with the application of Alternative 3, Scenario B, would be beneficial and of low to moderate impact for 14 populations, substantially negative for two populations (Puyallup and White River), and of a low negative magnitude for one population (Nisqually River). Model results of the effects of Alternative 3 on the Green, Sammamish, and Cedar River chinook salmon populations were less than 1 percent and therefore classed as immeasurable. For Scenarios A, C, or D, predicted impacts (relative to Alternative 1 Scenarios A, C, or D) would be nearly identical to those under Scenario B. Although small changes in escapement (Cedar, Sammamish and Skokomish populations) shifted impacts from low negative, to low beneficial, or no to low impact in some cases, the actual percentage changes were very small (see Table 4.3-4, Table 4.3-6, and Tables 4.3-9a-2 through 4.3-9d-2 in Subsection 4.3.1.5).

In summary, Alternative 3 represents a more restrictive fishing regime than Alternative 1 or Alternative 2, especially for populations in North Puget Sound; therefore, it is predicted that escapements in North Puget Sound watersheds would be higher compared to Alternative 1. For all but two South Puget

Sound populations (Puyallup River and White River), changes relative to Alterative 1 are predicted to be minimal (see Tables 4.3-4 and 4.3-5 in Subsection 4.3.1.5).

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 3, the Nooksack early management unit that makes up the Strait of Georgia region is predicted to exceed its RER; all eight [xi] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; and none of the populations in the Strait of Georgia Strait, Hood Canal, or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum

The catch of listed Hood Canal/Strait of Juan de Fuca summer chum (excluding those from the Quilcene/Dabob Bay Management Unit) is predicted to be zero, or 214 fewer than with Alternative 1, Scenario B. Under Alternative 3, there would be no summer chum harvested in Puget Sound fisheries. Therefore, the consequences would be the same as those described for Alternative 2. See Table 4.3-9a through 4.3-9d in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook and Hood Canal summer chum salmon.

4.3.1.4 Alternative 4 – No Action/No Authorized Take

Alternative 4, the most restrictive of the harvest management alternatives, is predicted to reduce catch and increase escapement of all populations of naturally-spawning Puget Sound chinook salmon relative to Alternative 1.

Summary or Scenario Differences

Under Alternative 4, Scenarios A, C, or D, representing conditions similar to 2003 (A); decreased forecast abundance (C); or decreased forecast abundance with maximized Canadian/Alaskan fisheries (D), Southern U.S. catch of naturally-spawning chinook is predicted to be 99 percent, 73 percent, and

[xi] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

73 percent, respectively, of that with Alternative 3, Scenario B. Catch of other species is discussed in Subsection 4.3.2, Basis of Comparison of Alternatives and Approach to Alternatives Analysis.

Modeled escapement patterns under Alternative 4, Scenarios A, C, or D were similar to those under Alternative 4, Scenario B. Decreased abundance under Scenarios C or D would result in predicted escapement for the Nooksack early populations falling below their CETs under Scenarios C or D, whereas escapement was above CET for Scenarios A or B for the North Fork Nooksack population. Decreased abundance under Scenarios C or D would result in predicted escapement for the Lower Skagit population falling below its VET in Scenarios C or D, whereas it exceeded VET in Scenarios A and B (see Table 4.3-5 and Tables 4.3-10a-1 through 4.3-10d-1in Subsection 4.3.1.5).

Comparison of Alternative 4 to Alternative 1 (Proposed Action)

Impacts to Puget Sound Chinook Populations

Under Alternative 4, Scenario B (high abundance and Canadian/Alaskan fisheries at the maximum allowed by treaty), the catch of Puget Sound chinook from naturally-spawning chinook populations is predicted to be 6,289 fish, or 46,648 fewer than with Alternative 1, Scenario B. The total chinook catch predicted under Alternative 4, Scenario B, is 150,891 fewer than with Alternative 1, Scenario B (see Table 4.3-2 in Subsection 4.3.1.5).

Catch of other species is discussed in Subsection 4.3.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis. See Tables 4.3-10a through 4.3-10d~~b~~ in Subsection 4.3.1.5 for a detailed listing of fishery-related impacts to individual populations of Puget Sound chinook and Hood Canal summer chum salmon.

Population-specific impacts of Alternative 4 under Scenario B, are predicted to be nearly identical to those of Alternative 2 or 3, Scenario B. Under Alternative 4, Scenario B, exploitation rates are predicted to be less than RER standards for all populations except in the Nooksack early management unit. Critical escapement thresholds are predicted to be exceeded for all populations except the North Fork Nooksack population.Viable escapement thresholds are predicted to be met or exceeded for the Lower Sauk, Upper Skagit, North Fork Stillaguamish, Upper Sauk, Suiattle, White River, the South Fork Stillaguamish, Green-Duwamish, Puyallup, Nisqually, and Skokomish chinook salmon populations (see Table 4.3-3 and Table 4.3-10b in Subsection 4.3.1.5).

For the Nooksack early management unit, the RER would be exceeded even without salmon fishing in Southern U.S. waters. For the Nooksack early chinook management unit, the probability of falling below its CET due to Southern U.S. fishing-related mortality is predicted to increase by 1 percentage point and the probability of rebuilding is predicted to decrease by 1 percentage point, measured over 25 years.

Alternative 4, the most restrictive of the alternatives, is predicted to reduce catch and increase escapement of all populations of naturally-spawning Puget Sound chinook salmon relative to Alternative 1. Increases in escapement are predicted to result in beneficial impacts of low to moderate magnitude for 16 of the 22 populations, and substantial beneficial impacts for four other populations. The four populations predicted to have substantial increases in spawning escapement under Alternative 4 relative to Alternative 1 are the Green, Puyallup, Nisqually, and Skokomish chinook salmon populations. Modeled spawning escapements for these populations predict exceedance of the VET by 84 percent, 163 percent, 196 percent, and 90 percent, respectively (see Table 4.3-4 and Table 4.3-10a-2 in Subsection 4.3.1.5). However, to some extent, the beneficial impact of increased escapement might be moderated by capacity of the extant habitats to support additional spawners and their progeny.

As would be expected, impacts associated with the application of Alternative 4 under Scenarios A, C, or D relative to Alternative 1, Scenarios A, C, or D, were similar in type and, in most cases, magnitude, to the impacts modeled under Scenario B. Two notable exceptions were the Green River and Puyallup River populations where substantial beneficial impacts were indicated under Scenarios A or B, but only moderately beneficial impacts under Scenarios C or D (lower abundance conditions). For the Cedar and Sammamish River populations, impacts are predicted to range from low and beneficial (Alternative 4, Scenario A or B) to low and adverse (Alternative 4, Scenarios C or D), compared to the same scenarios under Alternative 1. However, the actual change in numbers of fish in escapement is predicted to be no more than 1 percent (see Table 4.3-4 and Tables 4.3-10a-2 through 4.3-10d-2 in Subsection 4.3.1.5).

In summary, Alternative 4 represents the most restrictive fishing regime and would result in low to substantial increases in spawning escapement relative to Alternative 1. These increases would not necessarily result in beneficial impacts to all populations. (See discussion below.)

The TRT has identified five distinct geographic/life history regions in the Puget Sound Chinook Salmon ESU: the Strait of Georgia, North Puget Sound, South Puget Sound, Hood Canal, and the Strait of Juan de Fuca. Current TRT guidance recommends that a recovered ESU would have two to four low-risk populations within each region, representative of the range of life histories within each of the regions. Under Alternative 4, the Nooksack early populations that make up the Strait of Georgia region are predicted to exceed its RER; all eight[xii] North Puget Sound populations are predicted to meet their RER and/or exceed the VETs; four of the six South Puget Sound populations are predicted to exceed their VETs; one of the two populations in the Hood Canal region is predicted to exceed its VET; and none of the populations in the Strait of Georgia or the Strait of Juan de Fuca regions are predicted to exceed their VETs. Except for the North Fork Nooksack chinook population, all populations in all regions are predicted to exceed their CETs.

Impacts to Hood Canal and Strait of Juan de Fuca Summer Chum

Under Alternative 4, the catch from listed Hood Canal and Strait of Juan de Fuca summer chum salmon populations is predicted to be zero, compared to 214 and 12, respectively,~~141~~ under Alternative 1. Therefore, the consequences would be the same as those described for Alternative 2 or 3.

4.3.1.5 Summary Discussion of Alternatives

Under Alternative 1, the Proposed Action, RERs are predicted to be met under nearly all scenarios and within nearly all populations except the Nooksack early chinook management unit, and the Skykomish summer population. While the Skykomish summer population is predicted to meet the RER standard under most other alternatives and scenarios, the Nooksack early management unit is not predicted to meet its RER goal under any alternative or scenario. Failure of the Nooksack early populations to meet RERs and, in most instances, CETs, can be attributed to the fact that a high proportion of impacts to this population occur in fisheries outside of Puget Sound, not within the jurisdiction of the Resource Management Plan. Another notable exception is predicted for the Green River population. However, unlike the Nooksack population, the Green River population, despite exceeding RER ceilings under several alternative/scenario combinations, is predicted to meet or exceed its VET in all cases.

Critical escapement goals are predicted to be met for all populations under Alternative 1 except the North Fork Nooksack chinook salmon population, the South Fork Nooksack population under the lower abundance scenarios, and the South Fork Stillaguamish fall population under any scenario. The North Fork Nooksack population is not predicted to meet its CET under any alternative or scenario. Seventy percent or more of the fishing-related mortality on the Nooksack early chinook population occurs as a result of Canadian/Alaskan fisheries. Catch in fisheries covered by the Resource

[xii] There are ten populations in the North Puget Sound Region, but only eight currently have identified management standards.

Management Plan is predicted to be at most 36 fish; thus, there is likely to be little difference in the impact of any alternative.

Under Alternative 1, performance relative to VETs is predicted to vary considerably for the different populations. What would be consistent, however, is that certain populations are predicted to not meet VETs under most, if not all alternatives and scenarios. These include the Nooksack early, Lower Skagit, Skykomish, Sammamish, Cedar, Mid-Hood Canal, Skokomish, Dungeness, and Elwha River populations.

As noted previously, increasingly restrictive alternatives generally result in increased spawning escapement. Thus, application of Alternatives 2 through 4 appear to have a beneficial impact on most populations relative to Alternative 1. However, while spawning escapement provides a useful basis for comparing alternatives, the intricacy of salmon life histories must be taken into account in interpreting the model results.

First, substantial increases in spawning escapements may not result in commensurate increases in the progeny of those chinook salmon spawners. The objective for salmon fisheries management is to constrain fishing mortality to the extent necessary to optimize the production of subsequent generations. The productivity of salmon populations, often defined in terms of the number of recruits produced per female spawner, increases over a range of escapement, then reaches a plateau or declines at higher levels of escapement due to density-dependent survival; i.e., too many spawners for the available habitat, or too many juvenile salmon for the available food in the river. The escapement level corresponding to the point of optimum productivity varies widely among individual populations due to the accessible area of suitable spawning and rearing habitat within a river system, and the very complex array of physical and biological factors that influence the annual survival of salmon eggs and juveniles through their freshwater life history. However, the influence of these physical and biological factors varies greatly from year to year, so that were fisheries management to achieve optimum escapement consistently from year to year, the actual production from those spawners would still vary widely. The marine environment exerts even greater influence on the number of juvenile salmon that reach adulthood. Consequently, this Environmental Impact Statement can compare the predicted escapement for populations against specific or general escapement standards, but cannot accurately project the resulting abundance of subsequent generations of adult salmon. In addition, changes in risk relative to achievement of the RERs may not be the same as changes in risk measured by changes in escapement. That is, the changes in achieving the RERs are likely to be more beneficial or adverse relative to recovery than changes in escapement.

The harvest standards for the Hood Canal and Strait of Juan de Fuca Summer Chum Evolutionarily Significant Unit are predicted to be met under any alternative.

Table 4.3-2. Predicted Southern U.S. catch of Puget Sound chinook populations under Alternatives 1-4 and Scenarios A-D.

		Scenario A	Scenario B	Scenario C	Scenario D
Natural		55,512	45,249	32,256	31,238
Other	Alternative 1	110,994	111,931	83,808	81,058
Total		166,506	157,180	116,064	112,296
Natural		45,249	42,793	21,614	19,667
Other	Alternative 2	81,570	36,074	21,753	19,354
Total		126,819	78,867	43,367	39,021
Natural		41,931	39,231	20,785	18,885
Other	Alternative 3	65,565	30,201	21,753	19,354
Total		107,496	69,432	42,538	38,239
Natural		6,233	6,289	4,597	4,619
Other	Alternative 4				
Total		6,233	6,289	4,597	4,619

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-3. Performance of Alternatives 1 through 4 under Scenario B relative to rebuilding exploitation rate, critical escapement threshold, and viable escapement threshold standards.

	Performance Relative to Rebuilding Exploitation Rate				Performance Relative to Critical Escapement Threshold				Performance Relative to Viable Escapement Threshold			
	A-1	A-2	A-3	A-4	A-1	A-2	A-3	A-4	A-1	A-2	A-3	A-4
Nooksack Early*	N	N	N	N					N	N	N	N
North Fork					N	N	N	N	NA	NA	NA	NA
South Fork					Y	Y	Y	Y	NA	NA	NA	NA
Skagit Summer-Fall*												
Lower Skagit Fall	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	N
Lower Sauk Summer	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Upper Skagit Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skagit Spring*												
Upper Cascade	NA	NA	NA	NA	Y	Y	Y	Y				
Upper Sauk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suiattle	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Stillaguamish Summer-Fall*												
North Fork Summer	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Fork Fall	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y
Snohomish Summer-Fall*												
Skykomish Summer	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N
Snoqualmie Fall	NA	NA	NA	NA	Y	Y	Y	Y	NA	NA	NA	NA
Green-Duwamish Fall*	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lake Washington Fall												
Sammamish	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N
Cedar	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N
Puyallup Fall	NA	NA	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
White River Spring	NA	NA	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
Nisqually Fall	NA	NA	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y
Mid- Hood Canal Fall	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N
Skokomish Fall	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	Y
Dungeness Summer	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N
Elwha Summer	NA	NA	NA	NA	Y	Y	Y	Y	N	N	N	N

Y	Meets or exceeds goal.
N	Does not meet goal.
NA	Standard not applicable.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-4 Summary of impacts of Alternatives 2-4 relative to the proposed action under Scenario B

	Alternative 2 Compared to Alternative 1		**Alternative 3 Compared to Alternative 1**		**Alternative 4 Compared to Alternative 1**	
	Type	Extent	Type	Extent	Type	Extent
Nooksack Early	B	M	B	M	B	M
Lower Skagit Fall	B	M	B	M	B	M
Lower Sauk Summer	B	M	B	M	B	M
Upper Skagit Summer	B	M	B	M	B	M
Upper Cascade Spring	B	L	B	L	B	L
Upper Sauk Spring	B	L	B	L	B	L
Suiattle Spring	B	L	B	L	B	L
NF Stillaguamish Summer	N	S	B	L	B	L
SF Stillaguamish Fall	N	S	B	L	B	L
Skykomish Summer	N	L	B	M	B	M
Snoqualmie Fall	N	L	B	M	B	M
Green-Duwamish Fall	0	0	0	0	B	S
Sammamish Fall	0	0	0	0	0	0
Cedar Fall	0	0	0	0	0	0
Puyallup Fall	N	S	N	S	B	S
White River Spring	N	S	N	S	B	M
Nisqually Fall	N	L	N	L	B	S
Mid-Hood Canal Fall	B	L	B	L	B	L
Skokomish Fall	0	0	0	0	B	S
Dungeness Summer	B	L	B	L	B	L
Elwha Summer	B	L	B	L	B	L

Impact Type		Impact Magnitude	
Beneficial	B	Low (<10%)	L
Negative	N	Moderate (10%-30%)	M
None (not measurable)	0	Substantial (>30%)	S
		Not Measurable (<1%)	0

Table 4.3-5. Performance of Alternatives 1 through 4 under Scenarios A-D relative to rebuilding exploitation rate, critical escapement threshold, and viable escapement threshold standards.

Rebuilding Exploitation Rate

	Alternative 1				Alternative 2				Alternative 3				Alternative 4			
	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D
Nooksack Early*	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
North Fork																
South Fork																
Skagit Summer-Fall*																
Lower Skagit Fall	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lower Sauk Summer	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Upper Skagit Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skagit Spring*																
Upper Cascade	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Upper Sauk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suiattle	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Stillaguamish Summer-Fall*																
North Fork Summer	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
South Fork Fall	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Snohomish Summer-Fall*																
Skykomish Summer	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Snoqualmie Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Green-Duwamish Fall*	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Lake Washington Fall																
Sammamish	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cedar	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Puyallup Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
White River Spring	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nisqually Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mid- Hood Canal Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Skokomish Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dungeness Summer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Elwha Summer	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Critical Escapement Threhold

	Alternative 1				Alternative 2				Alternative 3				Alternative 4			
	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D
Nooksack Early*																
North Fork	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
South Fork	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N
Skagit Summer-Fall*																
Lower Skagit Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lower Sauk Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Upper Skagit Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skagit Spring*																
Upper Cascade	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Upper Sauk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suiattle	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Stillaguamish Summer-Fall*																
North Fork Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Fork Fall	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Snohomish Summer-Fall*																
Skykomish Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Snoqualmie Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Green-Duwamish Fall*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lake Washington Fall																
Sammamish	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cedar	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Puyallup Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
White River Spring	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nisqually Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mid- Hood Canal Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skokomish Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Dungeness Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Elwha Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Viable Escapement Threhold

	Alternative 1				Alternative 2				Alternative 3				Alternative 4			
	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D	S-A	S-B	S-C	S-D
Nooksack Early*	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
North Fork	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Fork	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Skagit Summer-Fall*																
Lower Skagit Fall	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Lower Sauk Summer	N	N	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N
Upper Skagit Summer	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skagit Spring*																
Upper Cascade																
Upper Sauk	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Suiattle	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Stillaguamish Summer-Fall*																
North Fork Summer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
South Fork Fall	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Snohomish Summer-Fall*																
Skykomish Summer	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Snoqualmie Fall	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Green-Duwamish Fall*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lake Washington Fall																
Sammamish	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Cedar	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Puyallup Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
White River Spring	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nisqually Fall	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mid- Hood Canal Fall	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Skokomish Fall	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y
Dungeness Summer	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Elwha Summer	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Y Meets or exceeds goal.
N Does not meet goal.
NA Standard not applicable.

Y Meets or exceeds goal.
N Does not meet goal.
NA Standard not applicable.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-6 Summary of impacts of alternatives 2-4 relative to the proposed action under scenarios 1-4.

	Alternative 2 Compared to Alternative 1								Alternative 3 Compared to Alternative 1								Alternative 4 Compared to Alternative 1							
	Scenario A		Scenario B		Scenario C		Scenario D		Scenario A		Scenario B		Scenario C		Scenario D		Scenario A		Scenario B		Scenario C		Scenario D	
	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent
Nooksack Early	B	L	B	M	B	L	B	M	B	L	B	M	B	L	B	M	B	L	B	M	B	L	B	M
Lower Skagit Fall	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
Lower Sauk Summer	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
Upper Skagit Summer	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
Upper Cascade Spring	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M
Upper Sauk Spring	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M
Suiattle Spring	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M	B	L	B	L	B	M	B	M
NF Stillaguamish Summer	N	S	N	S	N	S	N	S	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L
SF Stillaguamish Fall	N	S	N	S	N	S	N	S	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L
Skykomish Summer	N	L	N	L	B	L	B	L	B	L	B	M	B	L	B	L	B	L	B	M	B	L	B	L
Snoqualmie Fall	N	L	N	L	B	L	B	L	B	L	B	M	B	L	B	L	B	L	B	M	B	L	B	L
Green-Duwamish Fall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B	S	B	S	B	M	B	M
Sammamish Fall	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L
Cedar Fall	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L
Puyallup Fall	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	B	S	B	S	B	M	B	M
White River Spring	N	S	N	S	N	L	N	L	N	S	N	S	N	L	N	L	B	M	B	M	B	M	B	M
Nisqually Fall	N	L	N	L	N	L	N	L	N	L	N	L	N	L	N	L	B	S	B	S	B	S	B	S
Mid-Hood Canal Fall	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L
Skokomish Fall	B	L	0	0	N	L	N	L	B	L	0	0	N	L	N	L	B	S	B	S	B	S	B	S
Dungeness Summer	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L
Elwha Summer	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L	B	L

Impact Type

Beneficial	B
Negative	N
Not Measurable	0

Impact Extent

Low (<10%)	L
Moderate (10%-30%)	M
Substantial (>30%)	S
Not Measurable (<1%)	0

Table 4.3-7a Performance of Alternative 1 (Proposed Action) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 1 Scenario A**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	7%	37	388	8%		-22%
North Fork				171		-15%	
South Fork				217		9%	
Skagit Summer-Fall*	48%	18%	3,894	11,633			
Lower Skagit Fall				1,247	-1%	397%	-43%
Lower Sauk Summer				620	-3%	210%	-9%
Upper Skagit Summer				9,765	-12%	910%	31%
Skagit Spring*	23%	23%	570	1,921			
Upper Cascade				563		231%	
Upper Sauk				647	-15%	398%	96%
Suiattle				712	-18%	319%	78%
Stillaguamish Summer-F	17%	11%	313	2,322			
North Fork Summer				1,892	-15%	531%	243%
South Fork Fall				430	-7%	115%	43%
Snohomish Summer-Fal	19%	18%	2,325	5,073			
Skykomish Summer				2,604	-18%	58%	-26%
Snoqualmie Fall				2,469		517%	
Green-Duwamish Fall*	62%	51%	15,901	5,819	9%	597%	5%
Lake Washington Fall		20%					
Sammamish	31%		86	305		53%	-76%
Cedar	31%		87	305		53%	-75%
Puyallup Fall	49%	39%	5,024	2,392		1096%	99%
White River Spring	20%	19%	356	1,468		634%	47%
Nisqually Fall	76%	68%	17,425	1,106		453%	1%
Mid- Hood Canal Fall	26%	13%	95	531		166%	-58%
Skokomish Fall	63%	50%	9,372	1,211		506%	-3%
Dungeness Summer	22%	5%	15	352		76%	-62%
Elwha Summer	22%	5%	98	2,125		963%	-27%
All Chinook from Listed Populations			**55,599**	**36,951**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	3%	214	7,437	-8%	83%
Juan de Fuca	0.4%	12	6,955	-9%	656%
All Summer Chum		**226**	**14,392**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploiion rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7b Performance of Alternative 1 (Proposed Action) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 1 Scenario B**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	25%	8%	38	365	13%		-27%
North Fork				161		-20%	
South Fork				204		2%	
Skagit Summer-Fall*	55%	16%	3,737	11,029			
Lower Skagit Fall				1,183	6%	371%	-46%
Lower Sauk Summer				588	4%	194%	-14%
Upper Skagit Summer				9,258	-5%	857%	24%
Skagit Spring*	27%	23%	567	1,845			
Upper Cascade				541		218%	
Upper Sauk				622	-11%	378%	88%
Suiattle				684	-14%	302%	71%
Stillaguamish Summer-F	19%	11%	314	2,281			
North Fork Summer				1,859	-13%	520%	237%
South Fork Fall				422	-5%	111%	41%
Snohomish Summer-Fal	22%	18%	2,286	4,901			
Skykomish Summer				2,516	-18%	52%	-28%
Snoqualmie Fall				2,385		496%	
Green-Duwamish Fall*	63%	47%	15,103	5,816	10%	597%	5%
Lake Washington Fall		20%					
Sammamish	35%		86	294		47%	-76%
Cedar	35%		85	294		47%	-76%
Puyallup Fall	50%	35%	4,623	2,419		1110%	102%
White River Spring	20%	18%	323	1,459		630%	46%
Nisqually Fall	76%	65%	16,929	1,126		463%	2%
Mid- Hood Canal Fall	32%	13%	94	504		152%	-60%
Skokomish Fall	63%	44%	8,509	1,237		519%	-1%
Dungeness Summer	27%	5%	15	336		68%	-64%
Elwha Summer	28%	5%	97	2,031		916%	-30%
All Chinook from Listed Populations			**52,806**	**35,937**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	3%	214	7,437	-8%	83%
Juan de Fuca	0.4%	12	6,955	-9%	656%
All Summer Chum		**226**	**14,392**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7c Performance of Alternative 1 (Proposed Action) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 1 Scenario C**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	7%	26	278	8%		-44%
North Fork				122		-39%	
South Fork				156		-22%	
Skagit Summer-Fall*	49%	18%	2,778	8,033			
Lower Skagit Fall				861	0%	243%	-61%
Lower Sauk Summer				428	-2%	114%	-37%
Upper Skagit Summer				6,743	-11%	597%	-10%
Skagit Spring*	23%	23%	393	1,331			
Upper Cascade				390		129%	
Upper Sauk				449	-15%	245%	36%
Suiattle				493	-18%	190%	23%
Stillaguamish Summer-F	17%	12%	225	1,620			
North Fork Summer				1,320	-15%	340%	139%
South Fork Fall				300	-7%	50%	0%
Snohomish Summer-Fal	20%	18%	1,633	3,543			
Skykomish Summer				1,819	-18%	10%	-48%
Snoqualmie Fall				1,724		331%	
Green-Duwamish Fall*	49%	39%	9,185	5,801	-4%	595%	5%
Lake Washington Fall		23%					
Sammamish	33%		72	223		12%	-82%
Cedar	33%		72	223		12%	-81%
Puyallup Fall	50%	39%	3,772	1,798		799%	50%
White River Spring	20%	19%	243	1,011		406%	1%
Nisqually Fall	64%	56%	9,544	1,119		460%	2%
Mid- Hood Canal Fall	26%	12%	65	367		84%	-71%
Skokomish Fall	45%	31%	4,166	1,239		520%	-1%
Dungeness Summer	22%	5%	12	245		23%	-74%
Elwha Summer	23%	5%	70	1,480		640%	-49%
All Chinook from Listed Populations			**32,256**	**28,311**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	3%	214	7,437	-8%	83%
Juan de Fuca	0.4%	12	6,955	-9%	656%
All Summer Chum		**226**	**14,392**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-7d Performance of Alternative 1 (Proposed Action) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 1 Scenario D**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	26%	7%	27	252	14%		-50%
North Fork				111		-45%	
South Fork				141		-29%	
Skagit Summer-Fall*	56%	16%	2,698	7,551			
Lower Skagit Fall				810	7%	223%	-63%
Lower Sauk Summer				403	5%	101%	-41%
Upper Skagit Summer				6,339	-4%	556%	-15%
Skagit Spring*	28%	24%	415	1,270			
Upper Cascade				372		119%	
Upper Sauk				428	-10%	229%	30%
Suiattle				471	-13%	177%	18%
Stillaguamish Summer-F	20%	12%	239	1,584			
North Fork Summer				1,291	-12%	330%	134%
South Fork Fall				293	-4%	47%	-2%
Snohomish Summer-Fal	23%	18%	1,685	3,399			
Skykomish Summer				1,745	-18%	6%	-50%
Snoqualmie Fall				1,654		314%	
Green-Duwamish Fall*	51%	36%	8,768	5,802	-2%	595%	5%
Lake Washington Fall		22%					
Sammamish	38%		73	214		7%	-83%
Cedar	38%		74	214		7%	-82%
Puyallup Fall	50%	35%	3,464	1,834		817%	53%
White River Spring	20%	17%	219	1,011		406%	1%
Nisqually Fall	66%	53%	9,714	1,109		455%	1%
Mid- Hood Canal Fall	34%	12%	67	344		72%	-72%
Skokomish Fall	48%	26%	3,712	1,225		513%	-2%
Dungeness Summer	29%	5%	12	231		16%	-75%
Elwha Summer	30%	5%	71	1,395		598%	-52%
All Chinook from Listed Populations			**31,238**	**27,435**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	3%	214	7,437	-8%	83%
Juan de Fuca	0.4%	12	6,955	-9%	656%
All Summer Chum		**226**	**14,392**		

* Populations with specific NMFS-developed standards

1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

4 Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8a-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 2 Scenario A**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	8	422	2%	6%	-16%
North Fork				186		-7%	
South Fork				236		18%	
Skagit Summer-Fall*	32%	1%	147	14,656			
Lower Skagit Fall				1,571	-17%	526%	-28%
Lower Sauk Summer				782	-19%	291%	15%
Upper Skagit Summer				12,303	-28%	1172%	65%
Skagit Spring*	12%	3%	73	2,073			
Upper Cascade				607		257%	
Upper Sauk				699	-26%	437%	112%
Suiattle				768	-29%	352%	92%
Stillaguamish Summer-F	66%	60%	1,614	903			
North Fork Summer				736	34%	145%	33%
South Fork Fall				167	42%	-16%	-44%
Snohomish Summer-Fal	22%	21%	2,606	4,634			
Skykomish Summer				2,379	-18%	44%	-32%
Snoqualmie Fall				2,255		464%	
Green-Duwamish Fall*	55%	42%	11,312	5,800	2%	595%	5%
Lake Washington Fall		5%					
Sammamish	18%		18	307		54%	-75%
Cedar	18%		18	307		54%	-74%
Puyallup Fall	70%	57%	6,271	1,200		500%	0%
White River Spring	46%	46%	434	1,000		400%	0%
Nisqually Fall	72%	63%	14,375	1,100		450%	0%
Mid- Hood Canal Fall	19%	5%	39	552		176%	-56%
Skokomish Fall	60%	46%	8,334	1,218		509%	-3%
Dungeness Summer	19%	1%	3	360		80%	-61%
Elwha Summer	19%	1%	16	2,172		986%	-25%
All Chinook from Listed Populations			**45,268**	**36,704**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
4 Excludes Quilcene River population.
[shaded] Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8a-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	34	9%		
North Fork			15	9%	Beneficial	Low
South Fork			19	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-3,747	3,023	26%		
Lower Skagit Fall			324	26%	Beneficial	Moderate
Lower Sauk Summer			161	26%	Beneficial	Moderate
Upper Skagit Summer			2,538	26%	Beneficial	Moderate
Skagit Spring*	-11%	-497	152	8%	Beneficial	Low
Upper Cascade			45	8%	Beneficial	Low
Upper Sauk			51	8%	Beneficial	Low
Suiattle			56	8%	Beneficial	Low
Stillaguamish Summer-F	49%	1,301	-1,419	-61%		
North Fork Summer			-1,156	-61%	Negative	Substantial
South Fork Fall			-263	-61%	Negative	Substantial
Snohomish Summer-Fal	3%	281	-439	-9%		
Skykomish Summer			-225	-9%	Negative	Low
Snoqualmie Fall			-214	-9%	Negative	Low
Green-Duwamish Fall*	-7%	-4,589	-19	-0.3%	None	None
Lake Washington Fall						
Sammamish	-13%	-68	2	1%	Beneficial	Low
Cedar	-13%	-69	2	1%	Beneficial	Low
Puyallup Fall	21%	1,247	-1,192	-50%	Negative	Substantial
White River Spring	26%	78	-468	-32%	Negative	Substantial
Nisqually Fall	-4%	-3,050	-6	-1%	Negative	Low
Mid- Hood Canal Fall	-7%	-56	21	4%	Beneficial	Low
Skokomish Fall	-3%	-1,038	7	1%	Beneficial	Low
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-3%	-82	47	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
1 Alternative 1 - Alternative 2
2 (Alternative 1 - Alternative 2) ÷ Alternative 1
3 See explanation of impact metrics.
4 Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8b-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 2 Scenario B**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	19%	1%	9	412	7%		-18%
North Fork				181		-9%	
South Fork				231		15%	
Skagit Summer-Fall*	41%	1%	147	13,935			
Lower Skagit Fall				1,494	-8%	495%	-32%
Lower Sauk Summer				743	-10%	272%	9%
Upper Skagit Summer				11,698	-19%	1110%	57%
Skagit Spring*	16%	3%	74	2,009			
Upper Cascade				589		246%	
Upper Sauk				677	-22%	421%	105%
Suiattle				745	-25%	338%	86%
Stillaguamish Summer-F	67%	59%	1,591	904			
North Fork Summer				737	35%	146%	33%
South Fork Fall				167	43%	-16%	-44%
Snohomish Summer-Fal	23%	19%	2,347	4,603			
Skykomish Summer				2,363	-18%	43%	-32%
Snoqualmie Fall				2,240		460%	
Green-Duwamish Fall*	56%	38%	10,526	5,800	3%	595%	5%
Lake Washington Fall		5%					
Sammamish	23%		37	295		48%	-76%
Cedar	23%		18	295		48%	-75%
Puyallup Fall	71%	53%	5,990	1,200		500%	0%
White River Spring	46%	44%	414	1,000		400%	0%
Nisqually Fall	73%	60%	14,010	1,100		450%	0%
Mid- Hood Canal Fall	25%	5%	39	527		164%	-58%
Skokomish Fall	61%	40%	7,612	1,231		516%	-2%
Dungeness Summer	24%	1%	3	344		72%	-63%
Elwha Summer	24%	1%	16	2,079		940%	-28%
All Chinook from Listed Populations			**42,833**	**35,734**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8b-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario B**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	47	13%		
North Fork			21	13%	Beneficial	Moderate
South Fork			26	13%	Beneficial	Moderate
Skagit Summer-Fall*	-14%	-3,590	2,906	26%		
Lower Skagit Fall			312	26%	Beneficial	Moderate
Lower Sauk Summer			155	26%	Beneficial	Moderate
Upper Skagit Summer			2,439	26%	Beneficial	Moderate
Skagit Spring*	-11%	-493	164	9%	Beneficial	Low
Upper Cascade			48	9%	Beneficial	Low
Upper Sauk			55	9%	Beneficial	Low
Suiattle			61	9%	Beneficial	Low
Stillaguamish Summer-F	48%	1,277	-1,377	-60%		
North Fork Summer			-1,122	-60%	Negative	Substantial
South Fork Fall			-255	-60%	Negative	Substantial
Snohomish Summer-Fal	1%	61	-298	-6%		
Skykomish Summer			-153	-6%	Negative	Low
Snoqualmie Fall			-145	-6%	Negative	Low
Green-Duwamish Fall*	-7%	-4,577	-16	-0.3%	None	None
Lake Washington Fall						
Sammamish	-12%	-49	1	0%	None	None
Cedar	-12%	-67	1	0%	None	None
Puyallup Fall	21%	1,367	-1,219	-50%	Negative	Substantial
White River Spring	26%	91	-459	-31%	Negative	Substantial
Nisqually Fall	-3%	-2,919	-26	-2%	Negative	Low
Mid- Hood Canal Fall	-7%	-55	23	5%	Beneficial	Low
Skokomish Fall	-2%	-897	-6	0%	None	None
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-4%	-81	48	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative 1 Scenario B**					
	Wild Exploitation Rate[4]	Southern U.S. Catch [4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8c-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 2 Scenario C**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	6	304	2%		-39%
North Fork				134		-33%	
South Fork				170		-15%	
Skagit Summer-Fall*	33%	1%	105	10,215			
Lower Skagit Fall				1,095	-16%	336%	-50%
Lower Sauk Summer				545	-18%	172%	-20%
Upper Skagit Summer				8,575	-27%	787%	15%
Skagit Spring*	12%	3%	53	1,460			
Upper Cascade				428		152%	
Upper Sauk				492	-26%	278%	49%
Suiattle				541	-29%	218%	35%
Stillaguamish Summer-F	52%	46%	864	909			
North Fork Summer				741	20%	147%	34%
South Fork Fall				168	28%	-16%	-44%
Snohomish Summer-Fal	10%	3%	244	3,875			
Skykomish Summer				1,989	-18%	21%	-43%
Snoqualmie Fall				1,886		372%	
Green-Duwamish Fall*	36%	23%	4,403	5,800	-17%	595%	5%
Lake Washington Fall		5%					
Sammamish	19%		28	214		7%	-83%
Cedar	19%		13	214		7%	-82%
Puyallup Fall	57%	44%	3,703	1,200		500%	0%
White River Spring	23%	23%	156	1,000		400%	0%
Nisqually Fall	61%	51%	8,324	1,100		450%	0%
Mid- Hood Canal Fall	20%	5%	29	385		93%	-69%
Skokomish Fall	43%	29%	3,701	1,221		511%	-2%
Dungeness Summer	19%	1%	2	251		26%	-73%
Elwha Summer	19%	1%	11	1,516		658%	-48%
All Chinook from Listed Populations			**21,642**	**29,664**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
4 Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8c-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-20	26	9%		
North Fork			11	9%	Beneficial	Low
South Fork			15	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-2,673	2,182	27%		
Lower Skagit Fall			234	27%	Beneficial	Moderate
Lower Sauk Summer			116	27%	Beneficial	Moderate
Upper Skagit Summer			1,832	27%	Beneficial	Moderate
Skagit Spring*	-11%	-340	129	10%	Beneficial	Moderate
Upper Cascade			38	10%	Beneficial	Moderate
Upper Sauk			43	10%	Beneficial	Moderate
Suiattle			48	10%	Beneficial	Moderate
Stillaguamish Summer-F	35%	639	-711	-44%		
North Fork Summer			-579	-44%	Negative	Substantial
South Fork Fall			-132	-44%	Negative	Substantial
Snohomish Summer-Fal	-10%	-1,389	332	9%		
Skykomish Summer			170	9%	Beneficial	Low
Snoqualmie Fall			162	9%	Beneficial	Low
Green-Duwamish Fall*	-13%	-4,782	-1	0.0%	None	None
Lake Washington Fall						
Sammamish	-14%	-45	-9	-4%	Negative	Low
Cedar	-14%	-59	-9	-4%	Negative	Low
Puyallup Fall	7%	-69	-598	-33%	Negative	Substantial
White River Spring	3%	-87	-11	-1%	Negative	Low
Nisqually Fall	-3%	-1,220	-19	-2%	Negative	Low
Mid- Hood Canal Fall	-6%	-36	18	5%	Beneficial	Low
Skokomish Fall	-2%	-465	-18	-1%	Negative	Low
Dungeness Summer	-3%	-10	6	2%	Beneficial	Low
Elwha Summer	-4%	-59	36	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
1 Alternative 1 - Alternative 2
2 (Alternative 1 - Alternative 2) ÷ Alternative 1
3 See explanation of impact metrics.
4 Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8d-1 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 2 Scenario D**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	1%	6	285	8%		-43%
North Fork				125		-37%	
South Fork				160		-20%	
Skagit Summer-Fall*	43%	1%	105	9,625			
Lower Skagit Fall				1,032	-6%	311%	-53%
Lower Sauk Summer				513	-8%	157%	-25%
Upper Skagit Summer				8,080	-17%	736%	8%
Skagit Spring*	17%	3%	54	1,395			
Upper Cascade				409		140%	
Upper Sauk				470	-21%	262%	42%
Suiattle				517	-24%	204%	29%
Stillaguamish Summer-F	52%	43%	817	919			
North Fork Summer				749	20%	150%	36%
South Fork Fall				170	28%	-15%	-43%
Snohomish Summer-Fal	13%	3%	248	3,720			
Skykomish Summer				1,909	-18%	16%	-45%
Snoqualmie Fall				1,811		353%	
Green-Duwamish Fall*	38%	18%	3,685	5,800	-15%	595%	5%
Lake Washington Fall		5%					
Sammamish	25%		13	204		2%	-84%
Cedar	25%		13	204		2%	-83%
Puyallup Fall	59%	39%	3,449	1,200		500%	0%
White River Spring	22%	20%	137	1,000		400%	0%
Nisqually Fall	62%	47%	7,998	1,100		450%	0%
Mid- Hood Canal Fall	28%	5%	29	361		81%	-71%
Skokomish Fall	46%	23%	3,113	1,215		508%	-3%
Dungeness Summer	26%	1%	2	237		19%	-74%
Elwha Summer	26%	1%	11	1,431		616%	-51%
All Chinook from Listed Populations			**19,680**	**28,696**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

4 Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-8d-2 Performance of Alternative 2 (Escapement Goal Management at Management Unit Level) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-21	33	13%		
North Fork			15	13%	Beneficial	Moderate
South Fork			18	13%	Beneficial	Moderate
Skagit Summer-Fall*	-13%	-2,593	2,074	27%		
Lower Skagit Fall			222	27%	Beneficial	Moderate
Lower Sauk Summer			111	27%	Beneficial	Moderate
Upper Skagit Summer			1,741	27%	Beneficial	Moderate
Skagit Spring*	-11%	-361	125	10%	Beneficial	Moderate
Upper Cascade			37	10%	Beneficial	Moderate
Upper Sauk			42	10%	Beneficial	Moderate
Suiattle			46	10%	Beneficial	Moderate
Stillaguamish Summer-F	32%	578	-665	-42%		
North Fork Summer			-542	-42%	Negative	Substantial
South Fork Fall			-123	-42%	Negative	Substantial
Snohomish Summer-Fal	-10%	-1,437	321	9%		
Skykomish Summer			165	9%	Beneficial	Low
Snoqualmie Fall			156	9%	Beneficial	Low
Green-Duwamish Fall*	-13%	-5,083	-2	0.0%	None	None
Lake Washington Fall						
Sammamish	-13%	-60	-10	-5%	Negative	Low
Cedar	-13%	-61	-10	-5%	Negative	Low
Puyallup Fall	9%	-15	-634	-35%	Negative	Substantial
White River Spring	2%	-82	-11	-1%	Negative	Low
Nisqually Fall	-4%	-1,716	-9	-1%	Negative	Low
Mid- Hood Canal Fall	-6%	-38	17	5%	Beneficial	Low
Skokomish Fall	-2%	-599	-10	-1%	Negative	Low
Dungeness Summer	-3%	-10	6	3%	Beneficial	Low
Elwha Summer	-4%	-60	36	3%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch [4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

1 Alternative 1 - Alternative 2

2 (Alternative 1 - Alternative 2) ÷ Alternative 1

3 See explanation of impact metrics.

4 Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9a-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 3 Scenario A**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	8	422	2%		-16%
North Fork				186		-7%	
South Fork				236		18%	
Skagit Summer-Fall*	32%	1%	147	14,656			
Lower Skagit Fall				1,571	-17%	526%	-28%
Lower Sauk Summer				782	-19%	291%	15%
Upper Skagit Summer				12,303	-28%	1172%	65%
Skagit Spring*	12%	3%	71	2,074			
Upper Cascade				608		257%	
Upper Sauk				699	-26%	438%	112%
Suiattle				769	-29%	352%	92%
Stillaguamish Summer-Fal	8%	2%	47	2,468			
North Fork Summer				2,011	-24%	570%	264%
South Fork Fall				457	-16%	128%	52%
Snohomish Summer-Fall*	10%	4%	857	5,475			
Skykomish Summer				2,810	-18%	70%	-20%
Snoqualmie Fall				2,665		566%	
Green-Duwamish Fall*	55%	42%	11,312	5,800	2%	595%	5%
Lake Washington Fall		5%					
Sammamish	18%		18	307		54%	-75%
Cedar	18%		18	307		54%	-74%
Puyallup Fall	70%	57%	6,271	1,200		500%	0%
White River Spring	46%	46%	434	1,000		400%	0%
Nisqually Fall	72%	63%	14,375	1,100		450%	0%
Mid- Hood Canal Fall	19%	5%	39	552		176%	-56%
Skokomish Fall	60%	46%	8,333	1,218		509%	-3%
Dungeness Summer	19%	1%	3	360		80%	-61%
Elwha Summer	19%	1%	16	2,172		986%	-25%
All Chinook from Listed Populations			**41,949**	**39,111**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9a-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	34	9%		
North Fork			15	9%	Beneficial	Low
South Fork			19	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-3,747	3,023	26%		
Lower Skagit Fall			324	26%	Beneficial	Moderate
Lower Sauk Summer			161	26%	Beneficial	Moderate
Upper Skagit Summer			2,538	26%	Beneficial	Moderate
Skagit Spring*	-11%	-499	153	8%	Beneficial	Low
Upper Cascade			45	8%	Beneficial	Low
Upper Sauk			52	8%	Beneficial	Low
Suiattle			57	8%	Beneficial	Low
Stillaguamish Summer-Fal	-9%	-266	146	6%		
North Fork Summer			119	6%	Beneficial	Low
South Fork Fall			27	6%	Beneficial	Low
Snohomish Summer-Fall*	-9%	-1,468	402	8%		
Skykomish Summer			206	8%	Beneficial	Low
Snoqualmie Fall			196	8%	Beneficial	Low
Green-Duwamish Fall*	-7%	-4,589	-19	-0.3%	None	None
Lake Washington Fall						
Sammamish	-13%	-68	2	1%	Beneficial	Low
Cedar	-13%	-69	2	1%	Beneficial	Low
Puyallup Fall	21%	1,247	-1,192	-50%	Negative	Substantial
White River Spring	26%	78	-468	-32%	Negative	Substantial
Nisqually Fall	-4%	-3,050	-6	-1%	Negative	Low
Mid- Hood Canal Fall	-7%	-56	21	4%	Beneficial	Low
Skokomish Fall	-3%	-1,039	7	1%	Beneficial	Low
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-3%	-82	47	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch [4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9b-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 3 Scenario B**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	19%	1%	9	412	7%		-18%
North Fork				181		-9%	
South Fork				231		15%	
Skagit Summer-Fall*	41%	1%	147	13,935			
Lower Skagit Fall				1,494	-8%	495%	-32%
Lower Sauk Summer				743	-10%	272%	9%
Upper Skagit Summer				11,698	-19%	1110%	57%
Skagit Spring*	16%	3%	72	2,010			
Upper Cascade				589		246%	
Upper Sauk				677	-22%	421%	105%
Suiattle				745	-25%	338%	86%
Stillaguamish Summer-Fa	10%	2%	48	2,446			
North Fork Summer				1,993	-22%	564%	261%
South Fork Fall				453	-14%	126%	51%
Snohomish Summer-Fall*	12%	3%	328	5,368			
Skykomish Summer				2,755	-18%	67%	-21%
Snoqualmie Fall				2,613		553%	
Green-Duwamish Fall*	56%	38%	10,526	5,800	3%	595%	5%
Lake Washington Fall		5%					
Sammamish	23%		37	295		48%	-76%
Cedar	23%		18	295		48%	-75%
Puyallup Fall	71%	53%	5,990	1,200		500%	0%
White River Spring	46%	44%	414	1,000		400%	0%
Nisqually Fall	73%	60%	14,010	1,100		450%	0%
Mid- Hood Canal Fall	25%	5%	39	527		164%	-58%
Skokomish Fall	61%	40%	7,611	1,231		516%	-2%
Dungeness Summer	24%	1%	3	344		72%	-63%
Elwha Summer	24%	1%	16	2,079		940%	-28%
All Chinook from Listed Populations			**39,268**	**38,042**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9b-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario B**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	47	13%		
North Fork			21	13%	Beneficial	Moderate
South Fork			26	13%	Beneficial	Moderate
Skagit Summer-Fall*	-14%	-3,590	2,906	26%		
Lower Skagit Fall			312	26%	Beneficial	Moderate
Lower Sauk Summer			155	26%	Beneficial	Moderate
Upper Skagit Summer			2,439	26%	Beneficial	Moderate
Skagit Spring*	-11%	-495	165	9%	Beneficial	Low
Upper Cascade			48	9%	Beneficial	Low
Upper Sauk			56	9%	Beneficial	Low
Suiattle			61	9%	Beneficial	Low
Stillaguamish Summer-Fa	-9%	-266	165	7%		
North Fork Summer			134	7%	Beneficial	Low
South Fork Fall			31	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,958	467	10%		
Skykomish Summer			240	10%	Beneficial	Moderate
Snoqualmie Fall			227	10%	Beneficial	Moderate
Green-Duwamish Fall*	-7%	-4,577	-16	-0.3%	None	None
Lake Washington Fall						
Sammamish	-12%	-49	1	0%	None	None
Cedar	-12%	-67	1	0%	None	None
Puyallup Fall	21%	1,367	-1,219	-50%	Negative	Substantial
White River Spring	26%	91	-459	-31%	Negative	Substantial
Nisqually Fall	-3%	-2,919	-26	-2%	Negative	Low
Mid- Hood Canal Fall	-7%	-55	23	5%	Beneficial	Low
Skokomish Fall	-2%	-898	-6	0%	None	None
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-4%	-81	48	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario B**					
	Wild Exploitation Rate[4]	Southern U.S. Catch [4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9c-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario C relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative C Scenario C**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	6	304	2%		-39%
North Fork				134		-33%	
South Fork				170		-15%	
Skagit Summer-Fall*	33%	1%	105	10,215			
Lower Skagit Fall				1,095	-16%	336%	-50%
Lower Sauk Summer				545	-18%	172%	-20%
Upper Skagit Summer				8,575	-27%	787%	15%
Skagit Spring*	12%	3%	53	1,460			
Upper Cascade				428		152%	
Upper Sauk				492	-26%	278%	49%
Suiattle				541	-29%	218%	35%
Stillaguamish Summer-Fal	8%	2%	35	1,738			
North Fork Summer				1,416	-24%	372%	157%
South Fork Fall				322	-16%	61%	7%
Snohomish Summer-Fall*	10%	3%	244	3,875			
Skykomish Summer				1,989	-18%	21%	-43%
Snoqualmie Fall				1,886		372%	
Green-Duwamish Fall*	36%	23%	4,403	5,800	-17%	595%	5%
Lake Washington Fall		5%					
Sammamish	19%		28	214		7%	-83%
Cedar	19%		13	214		7%	-82%
Puyallup Fall	57%	44%	3,703	1,200		500%	0%
White River Spring	23%	23%	156	1,000		400%	0%
Nisqually Fall	61%	51%	8,324	1,100		450%	0%
Mid- Hood Canal Fall	20%	5%	29	385		93%	-69%
Skokomish Fall	43%	29%	3,701	1,221		511%	-2%
Dungeness Summer	19%	1%	2	251		26%	-73%
Elwha Summer	19%	1%	11	1,516		658%	-48%
All Chinook from Listed Populations			**20,813**	**30,493**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9c-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-20	26	9%		
North Fork			11	9%	Beneficial	Low
South Fork			15	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-2,673	2,182	27%		
Lower Skagit Fall			234	27%	Beneficial	Moderate
Lower Sauk Summer			116	27%	Beneficial	Moderate
Upper Skagit Summer			1,832	27%	Beneficial	Moderate
Skagit Spring*	-11%	-340	129	10%	Beneficial	Moderate
Upper Cascade			38	10%	Beneficial	Moderate
Upper Sauk			43	10%	Beneficial	Moderate
Suiattle			48	10%	Beneficial	Moderate
Stillaguamish Summer-Fal	-9%	-190	118	7%		
North Fork Summer			96	7%	Beneficial	Low
South Fork Fall			22	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,389	332	9%		
Skykomish Summer			170	9%	Beneficial	Low
Snoqualmie Fall			162	9%	Beneficial	Low
Green-Duwamish Fall*	-13%	-4,782	-1	0.0%	None	None
Lake Washington Fall						
Sammamish	-14%	-45	-9	-4%	Negative	Low
Cedar	-14%	-59	-9	-4%	Negative	Low
Puyallup Fall	7%	-69	-598	-33%	Negative	Substantial
White River Spring	3%	-87	-11	-1%	Negative	Low
Nisqually Fall	-3%	-1,220	-19	-2%	Negative	Low
Mid- Hood Canal Fall	-6%	-36	18	5%	Beneficial	Low
Skokomish Fall	-2%	-465	-18	-1%	Negative	Low
Dungeness Summer	-3%	-10	6	2%	Beneficial	Low
Elwha Summer	-4%	-59	36	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S. Catch[4]	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9d-1 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 3 Scenario D**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	1%	6	285	8%		-43%
North Fork				125		-37%	
South Fork				160		-20%	
Skagit Summer-Fall*	43%	1%	105	9,625			
Lower Skagit Fall				1,032	-6%	311%	-53%
Lower Sauk Summer				513	-8%	157%	-25%
Upper Skagit Summer				8,080	-17%	736%	8%
Skagit Spring*	17%	3%	54	1,395			
Upper Cascade				409		140%	
Upper Sauk				470	-21%	262%	42%
Suiattle				517	-24%	204%	29%
Stillaguamish Summer-Fal	11%	2%	35	1,702			
North Fork Summer				1,387	-21%	362%	151%
South Fork Fall				315	-13%	57%	5%
Snohomish Summer-Fall*	13%	3%	248	3,720			
Skykomish Summer				1,909	-18%	16%	-45%
Snoqualmie Fall				1,811		353%	
Green-Duwamish Fall*	38%	18%	3,685	5,800	-15%	595%	5%
Lake Washington Fall		5%					
Sammamish	25%		28	204		2%	-84%
Cedar	25%		13	204		2%	-83%
Puyallup Fall	59%	39%	3,449	1,200		500%	0%
White River Spring	22%	20%	137	1,000		400%	0%
Nisqually Fall	62%	47%	7,998	1,100		450%	0%
Mid- Hood Canal Fall	28%	5%	29	361		81%	-71%
Skokomish Fall	46%	23%	3,113	1,215		508%	-3%
Dungeness Summer	26%	1%	2	237		19%	-74%
Elwha Summer	26%	1%	11	1,431		616%	-51%
All Chinook from Listed Populations			**18,913**	**29,479**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch [4]	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards
[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])
[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])
[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}
[4] Excludes Quilcene River population.
Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-9d-2 Performance of Alternative 3 (Escapement Goal Management at Population Level) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario A**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-21	33	13%		
North Fork			15	13%	Beneficial	Moderate
South Fork			18	13%	Beneficial	Moderate
Skagit Summer-Fall*	-13%	-2,593	2,074	27%		
Lower Skagit Fall			222	27%	Beneficial	Moderate
Lower Sauk Summer			111	27%	Beneficial	Moderate
Upper Skagit Summer			1,741	27%	Beneficial	Moderate
Skagit Spring*	-11%	-361	125	10%	Beneficial	Moderate
Upper Cascade			37	10%	Beneficial	Moderate
Upper Sauk			42	10%	Beneficial	Moderate
Suiattle			46	10%	Beneficial	Moderate
Stillaguamish Summer-Fal	-9%	-204	118	7%		
North Fork Summer			96	7%	Beneficial	Low
South Fork Fall			22	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,437	321	9%		
Skykomish Summer			165	9%	Beneficial	Low
Snoqualmie Fall			156	9%	Beneficial	Low
Green-Duwamish Fall*	-13%	-5,083	-2	0.0%	None	None
Lake Washington Fall						
Sammamish	-13%	-45	-10	-5%	Negative	Low
Cedar	-13%	-61	-10	-5%	Negative	Low
Puyallup Fall	9%	-15	-634	-35%	Negative	Substantial
White River Spring	2%	-82	-11	-1%	Negative	Low
Nisqually Fall	-4%	-1,716	-9	-1%	Negative	Low
Mid- Hood Canal Fall	-6%	-38	17	5%	Beneficial	Low
Skokomish Fall	-2%	-599	-10	-1%	Negative	Low
Dungeness Summer	-3%	-10	6	3%	Beneficial	Low
Elwha Summer	-4%	-60	36	3%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative A Scenario A**					
	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards
[1] Alternative 1 - Alternative 2
[2] (Alternative 1 - Alternative 2) ÷ Alternative 1
[3] See explanation of impact metrics.
[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10a-1 Performance of Alternative 4 (No Fishing) under Scenario A relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	Alternative 4 Scenario A				Performance vs. Recovery Standards		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	8	422	2%		-16%
North Fork				186		-7%	
South Fork				236		18%	
Skagit Summer-Fall*	32%	1%	147	14,656			
Lower Skagit Fall				1,571	-17%	526%	-28%
Lower Sauk Summer				782	-19%	291%	15%
Upper Skagit Summer				12,303	-28%	1172%	65%
Skagit Spring*	12%	3%	71	2,074			
Upper Cascade				608		257%	
Upper Sauk				699	-26%	438%	112%
Suiattle				769	-29%	352%	92%
Stillaguamish Summer-Fal	8%	2%	47	2,468			
North Fork Summer				2,011	-24%	570%	264%
South Fork Fall				457	-16%	128%	52%
Snohomish Summer-Fall*	9%	3%	329	5,504			
Skykomish Summer				2,825	-18%	71%	-19%
Snoqualmie Fall				2,679		570%	
Green-Duwamish Fall*	18%	5%	1,675	10,558	-35%	1164%	91%
Lake Washington Fall		5%					
Sammamish	18%		37	307		54%	-75%
Cedar	18%		18	307		54%	-74%
Puyallup Fall	18%	5%	629	3,286		1543%	174%
White River Spring	2%	1%	18	1,831		816%	83%
Nisqually Fall	16%	7%	2,142	3,338		1569%	203%
Mid- Hood Canal Fall	19%	5%	39	552		176%	-56%
Skokomish Fall	19%	5%	1,054	2,482		1141%	99%
Dungeness Summer	19%	1%	3	360		80%	-61%
Elwha Summer	19%	1%	16	2,172		986%	-25%
All Chinook from Listed Populations			**6,233**	**50,317**			

Hood Canal and Strait of Juan de Fuca Summer Chum				Performance vs Recovery Standards	
	Wild Exploitation Rate[4]	Southern U.S. Catch	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10a-2 Performance of Alternative 4 (No Fishing) under Scenario A relative to Alternative 1 Scenario A (Proposed Action).

Puget Sound Chinook	Impacts Relative to Alternative 1 Scenario A					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	34	9%		
North Fork			15	9%	Beneficial	Low
South Fork			19	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-3,747	3,023	26%		
Lower Skagit Fall			324	26%	Beneficial	Moderate
Lower Sauk Summer			161	26%	Beneficial	Moderate
Upper Skagit Summer			2,538	26%	Beneficial	Moderate
Skagit Spring*	-11%	-499	153	8%	Beneficial	Low
Upper Cascade			45	8%	Beneficial	Low
Upper Sauk			52	8%	Beneficial	Low
Suiattle			57	8%	Beneficial	Low
Stillaguamish Summer-Fal	-9%	-266	146	6%		
North Fork Summer			119	6%	Beneficial	Low
South Fork Fall			27	6%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,996	431	8%		
Skykomish Summer			221	8%	Beneficial	Low
Snoqualmie Fall			210	8%	Beneficial	Low
Green-Duwamish Fall*	-44%	-14,226	4,739	81.4%	Beneficial	Substantial
Lake Washington Fall						
Sammamish	-13%	-49	2	1%	Beneficial	Low
Cedar	-13%	-69	2	1%	Beneficial	Low
Puyallup Fall	-31%	-4,395	894	37%	Beneficial	Substantial
White River Spring	-18%	-338	363	25%	Beneficial	Moderate
Nisqually Fall	-60%	-15,283	2,232	202%	Beneficial	Substantial
Mid- Hood Canal Fall	-7%	-56	21	4%	Beneficial	Low
Skokomish Fall	-44%	-8,318	1,271	105%	Beneficial	Substantial
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-3%	-82	47	2%	Beneficial	Low

Summer Chum	Impacts Relative to Alternative A Scenario A					
	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10b-1 Performance of Alternative 4 (No Fishing) under Scenario B relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 4 Scenario B**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	19%	1%	9	412	7%		-18%
North Fork				181		-9%	
South Fork				231		15%	
Skagit Summer-Fall*	41%	1%	147	13,935			
Lower Skagit Fall				1,494	-8%	495%	-32%
Lower Sauk Summer				743	-10%	272%	9%
Upper Skagit Summer				11,698	-19%	1110%	57%
Skagit Spring*	16%	3%	72	2,010			
Upper Cascade				589		246%	
Upper Sauk				677	-22%	421%	105%
Suiattle				745	-25%	338%	86%
Stillaguamish Summer-Fal	10%	2%	48	2,446			
North Fork Summer				1,993	-22%	564%	261%
South Fork Fall				453	-14%	126%	51%
Snohomish Summer-Fall*	12%	3%	328	5,368			
Skykomish Summer				2,755	-18%	67%	-21%
Snoqualmie Fall				2,613		553%	
Green-Duwamish Fall*	23%	5%	1,684	10,153	-30%	1116%	84%
Lake Washington Fall		5%					
Sammamish	23%		37	295		48%	-76%
Cedar	23%		18	295		48%	-75%
Puyallup Fall	23%	5%	633	3,160		1480%	163%
White River Spring	3%	1%	18	1,792		796%	79%
Nisqually Fall	21%	7%	2,183	3,261		1531%	196%
Mid- Hood Canal Fall	25%	5%	39	527		164%	-58%
Skokomish Fall	25%	5%	1,054	2,370		1085%	90%
Dungeness Summer	24%	1%	3	344		72%	-63%
Elwha Summer	24%	1%	16	2,079		940%	-28%
All Chinook from Listed Populations			**6,289**	**48,447**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate[4]	Southern U.S. Catch	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

(shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10b-2 Performance of Alternative 4 (No Fishing) under Scenario B relative to Alternative 1 Scenario B (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario B**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-29	47	13%		
North Fork			21	13%	Beneficial	Moderate
South Fork			26	13%	Beneficial	Moderate
Skagit Summer-Fall*	-14%	-3,590	2,906	26%		
Lower Skagit Fall			312	26%	Beneficial	Moderate
Lower Sauk Summer			155	26%	Beneficial	Moderate
Upper Skagit Summer			2,439	26%	Beneficial	Moderate
Skagit Spring*	-11%	-495	165	9%	Beneficial	Low
Upper Cascade			48	9%	Beneficial	Low
Upper Sauk			56	9%	Beneficial	Low
Suiattle			61	9%	Beneficial	Low
Stillaguamish Summer-Fal	-9%	-266	165	7%		
North Fork Summer			134	7%	Beneficial	Low
South Fork Fall			31	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,958	467	10%		
Skykomish Summer			240	10%	Beneficial	Moderate
Snoqualmie Fall			227	10%	Beneficial	Moderate
Green-Duwamish Fall*	-40%	-13,419	4,337	74.6%	Beneficial	Substantial
Lake Washington Fall						
Sammamish	-12%	-49	1	0%	None	None
Cedar	-12%	-67	1	0%	None	None
Puyallup Fall	-27%	-3,990	741	31%	Beneficial	Substantial
White River Spring	-17%	-305	333	23%	Beneficial	Moderate
Nisqually Fall	-55%	-14,746	2,135	190%	Beneficial	Substantial
Mid- Hood Canal Fall	-7%	-55	23	5%	Beneficial	Low
Skokomish Fall	-38%	-7,455	1,133	92%	Beneficial	Substantial
Dungeness Summer	-3%	-12	8	2%	Beneficial	Low
Elwha Summer	-4%	-81	48	2%	Beneficial	Low

Summer Chum	**Impacts Relative to Alternative 1 Scenario B**					
	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10c-1 Performance of Alternative 4 (No Fishing) under Scenario Crelative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	**Alternative 4 Scenario C**				**Performance vs. Recovery Standards**		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	14%	1%	6	304	2%		-39%
North Fork				134		-33%	
South Fork				170		-15%	
Skagit Summer-Fall*	33%	1%	105	10,215			
Lower Skagit Fall				1,095	-16%	336%	-50%
Lower Sauk Summer				545	-18%	172%	-20%
Upper Skagit Summer				8,575	-27%	787%	15%
Skagit Spring*	12%	3%	53	1,460			
Upper Cascade				428		152%	
Upper Sauk				492	-26%	278%	49%
Suiattle				541	-29%	218%	35%
Stillaguamish Summer-Fal	8%	2%	35	1,738			
North Fork Summer				1,416	-24%	372%	157%
South Fork Fall				322	-16%	61%	7%
Snohomish Summer-Fall*	10%	3%	244	3,875			
Skykomish Summer				1,989	-18%	21%	-43%
Snoqualmie Fall				1,886		372%	
Green-Duwamish Fall*	19%	5%	1,228	7,367	-34%	782%	33%
Lake Washington Fall		5%					
Sammamish	19%		27	214		7%	-83%
Cedar	19%		13	214		7%	-82%
Puyallup Fall	19%	5%	461	2,293		1047%	91%
White River Spring	2%	1%	14	1,283		542%	28%
Nisqually Fall	17%	8%	1,600	2,330		1065%	112%
Mid- Hood Canal Fall	20%	5%	29	385		93%	-69%
Skokomish Fall	20%	5%	769	1,730		765%	38%
Dungeness Summer	19%	1%	2	251		26%	-73%
Elwha Summer	19%	1%	11	1,516		658%	-48%
All Chinook from Listed Populations			**4,597**	**35,175**			

Hood Canal and Strait of Juan de Fuca Summer Chum				**Performance vs Recovery Standards**	
	Wild Exploitation Rate [4]	Southern U.S. Catch	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

1 Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

2 Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

3 Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

4 Excludes Quilcene River population.

Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10c-2 Performance of Alternative 4 (No Fishing) under Scenario C relative to Alternative 1 Scenario C (Proposed Action).

Puget Sound Chinook	**Impacts Relative to Alternative 1 Scenario C**					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-20	26	9%		
North Fork			11	9%	Beneficial	Low
South Fork			15	9%	Beneficial	Low
Skagit Summer-Fall*	-16%	-2,673	2,182	27%		
Lower Skagit Fall			234	27%	Beneficial	Moderate
Lower Sauk Summer			116	27%	Beneficial	Moderate
Upper Skagit Summer			1,832	27%	Beneficial	Moderate
Skagit Spring*	-11%	-340	129	10%	Beneficial	Moderate
Upper Cascade			38	10%	Beneficial	Moderate
Upper Sauk			43	10%	Beneficial	Moderate
Suiattle			48	10%	Beneficial	Moderate
Stillaguamish Summer-Fal	-9%	-190	118	7%		
North Fork Summer			96	7%	Beneficial	Low
South Fork Fall			22	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,389	332	9%		
Skykomish Summer			170	9%	Beneficial	Low
Snoqualmie Fall			162	9%	Beneficial	Low
Green-Duwamish Fall*	-30%	-7,957	1,566	27.0%	Beneficial	Moderate
Lake Washington Fall						
Sammamish	-14%	-45	-9	-4%	Negative	Low
Cedar	-14%	-59	-9	-4%	Negative	Low
Puyallup Fall	-31%	-3,311	495	28%	Beneficial	Moderate
White River Spring	-18%	-229	272	27%	Beneficial	Moderate
Nisqually Fall	-47%	-7,944	1,211	108%	Beneficial	Substantial
Mid- Hood Canal Fall	-6%	-36	18	5%	Beneficial	Low
Skokomish Fall	-25%	-3,397	491	40%	Beneficial	Substantial
Dungeness Summer	-3%	-10	6	2%	Beneficial	Low
Elwha Summer	-4%	-59	36	2%	Beneficial	Low

	Impacts Relative to Alternative 1 Scenario C					
Summer Chum	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

1 Alternative 1 - Alternative 2

2 (Alternative 1 - Alternative 2) ÷ Alternative 1

3 See explanation of impact metrics.

4 Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10d-1 Performance of Alternative 4 (No Fishing) under Scenario D relative to NMFS recovery standards, viable salmonid population guidelines, and current condition escapement goals for listed Puget Sound chinook and Hood Canal-Strait of Juan de Fuca summer chum salmon.

Puget Sound Chinook	Alternative 4 Scenario D				Performance vs. Recovery Standards		
	Wild Exploitation Rate	Southern U.S. Wild Exploitation Rate	Southern U.S.Catch	Natural Escapement	Rebuilding Exploitation Rate[1]	Critical Escapement Threshold[2]	Viable Escapement or Escapement Goal[3]
Nooksack Early*	20%	1%	6	285	8%		-43%
North Fork				125		-37%	
South Fork				160		-20%	
Skagit Summer-Fall*	43%	1%	105	9,625			
Lower Skagit Fall				1,032	-6%	311%	-53%
Lower Sauk Summer				513	-8%	157%	-25%
Upper Skagit Summer				8,080	-17%	736%	8%
Skagit Spring*	17%	3%	54	1,395			
Upper Cascade				409		140%	
Upper Sauk				470	-21%	262%	42%
Suiattle				517	-24%	204%	29%
Stillaguamish Summer-Fal	11%	2%	35	1,702			
North Fork Summer				1,387	-21%	362%	151%
South Fork Fall				315	-13%	57%	5%
Snohomish Summer-Fall*	13%	3%	244	3,720			
Skykomish Summer				1,909	-18%	16%	-45%
Snoqualmie Fall				1,811		353%	
Green-Duwamish Fall*	25%	5%	1,232	7,006	-28%	739%	27%
Lake Washington Fall		5%					
Sammamish	25%		13	204		2%	-84%
Cedar	25%		13	204		2%	-83%
Puyallup Fall	25%	5%	463	2,180		990%	82%
White River Spring	3%	1%	14	1,246		523%	25%
Nisqually Fall	23%	8%	1,630	2,264		1032%	106%
Mid- Hood Canal Fall	28%	5%	29	361		81%	-71%
Skokomish Fall	28%	5%	767	1,622		711%	30%
Dungeness Summer	26%	1%	2	237		19%	-74%
Elwha Summer	26%	1%	11	1,431		616%	-51%
All Chinook from Listed Populations			**4,619**	**33,482**			

Hood Canal and Strait of Juan de Fuca Summer Chum				Performance vs Recovery Standards	
	Wild Exploitation Rate[4]	Southern U.S. Catch	Natural Escapement	Rebuilding Exploitation Rate	Critical Escapement Threshold
Hood Canal	0.3%	0	7,651	-11%	88%
Juan de Fuca	0.2%	0	6,985	-9%	659%
All Summer Chum		**0**	**14,636**		

* Populations with specific NMFS-developed standards

[1] Calculated as difference of rates ([predicted wild exploition rate - recovery exploitation rate])

[2] Calculated as percent of difference ([predicted escapement-critical escapement threshold ÷ critical escapement threshold])

[3] Calculated as percent of difference (predicted escapement-viable escapement threshold ÷ viable escapement threshold]}

[4] Excludes Quilcene River population.

(Shaded) Indicates exploitation rate or escapement does not meet standard.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-10d-2 Performance of Alternative 4 (No Fishing) under Scenario D relative to Alternative 1 Scenario D (Proposed Action).

Puget Sound Chinook	Impacts Relative to Alternative 1 Scenario D					
	Change in Wild Exploitation Rate[1]	Change in Southern U.S. Catch[1]	Change in Natural Escapement[1]	% Change in Natural Escapement[2]	Type of Impact	Magnitude of Impact
Nooksack Early*	-6%	-21	33	13%		
North Fork			15	13%	Beneficial	Moderate
South Fork			18	13%	Beneficial	Moderate
Skagit Summer-Fall*	-13%	-2,593	2,074	27%		
Lower Skagit Fall			222	27%	Beneficial	Moderate
Lower Sauk Summer			111	27%	Beneficial	Moderate
Upper Skagit Summer			1,741	27%	Beneficial	Moderate
Skagit Spring*	-11%	-361	125	10%	Beneficial	Moderate
Upper Cascade			37	10%	Beneficial	Moderate
Upper Sauk			42	10%	Beneficial	Moderate
Suiattle			46	10%	Beneficial	Moderate
Stillaguamish Summer-Fal	-9%	-204	118	7%		
North Fork Summer			96	7%	Beneficial	Low
South Fork Fall			22	7%	Beneficial	Low
Snohomish Summer-Fall*	-10%	-1,441	321	9%		
Skykomish Summer			165	9%	Beneficial	Low
Snoqualmie Fall			156	9%	Beneficial	Low
Green-Duwamish Fall*	-26%	-7,536	1,204	20.8%	Beneficial	Moderate
Lake Washington Fall						
Sammamish	-13%	-60	-10	-5%	Negative	Low
Cedar	-13%	-61	-10	-5%	Negative	Low
Puyallup Fall	-25%	-3,001	346	19%	Beneficial	Moderate
White River Spring	-17%	-205	235	23%	Beneficial	Moderate
Nisqually Fall	-43%	-8,084	1,155	104%	Beneficial	Substantial
Mid- Hood Canal Fall	-6%	-38	17	5%	Beneficial	Low
Skokomish Fall	-20%	-2,945	397	32%	Beneficial	Substantial
Dungeness Summer	-3%	-10	6	3%	Beneficial	Low
Elwha Summer	-4%	-60	36	3%	Beneficial	Low

Summer Chum	Impacts Relative to Alternative 1 Scenario D					
	Wild Exploitation Rate[4]	Southern U.S.Catch	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Hood Canal	-3%	-214	214	3%	Beneficial	Low
Juan de Fuca	0%	-12	30	0%	None	None

* Populations with specific NMFS-developed standards

[1] Alternative 1 - Alternative 2

[2] (Alternative 1 - Alternative 2) ÷ Alternative 1

[3] See explanation of impact metrics.

[4] Excludes Quilcene River population.

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

4.3.2 Unlisted Salmonid Species

Puget Sound populations of coho, sockeye, pink, chum salmon, and steelhead would also be affected by the Proposed Action or alternatives considered in this Environmental Impact Statement. As noted in Section 3.3, Fish: Affected Environment, chinook and coho salmon from Washington and Oregon coastal populations are infrequently taken in Puget Sound fisheries, and therefore would not be measurably affected. The co-managers aggregate populations of sockeye, coho, pink, chum salmon, and steelhead into seven management units: the Nooksack-Samish, Skagit, Stillaguamish, and Snohomish River management units in North Puget Sound; the South Sound management unit, which includes streams south of the Snohomish; the Hood Canal management unit; and the Strait of Juan de Fuca management unit. The two sockeye salmon management units – the Skagit (Baker) River and South Puget Sound (Cedar River) – are managed to achieve escapement goals. Coho salmon harvest is managed to not exceed exploitation rate ceilings specific to each management unit. These exploitation rate ceilings would be set annually according to the forecast abundance of each management unit, and appropriate to the productivity level implied by the forecast. Pink and chum salmon fisheries are managed to achieve escapement goals for each management unit. Since these coho, chum, sockeye, pink salmon, and steelhead populations are unlisted populations, NMFS has not set Endangered Species Act standards for them. The standards of performance referred to in this Environmental Impact Statement are the exploitation rate ceilings, or escapement goals established by the co-managers beginning with the 2001 management year.

The alternatives considered all assume that river fisheries could remain open from December through March when adult chinook salmon are absent from Puget Sound streams. More than 95 percent of the net harvest of steelhead occurs during this period. The model employed in the analysis is able to account for the relatively small changes in tribal harvest that would occur in late summer and fall fisheries when chinook salmon and summer steelhead presence overlaps. Under Alternative 2 or 3, catch in these fisheries would be reduced relative to Alternative 1. Because such a large part of steelhead harvest occurs between December and March, the effect on catch and escapement of steelhead under Alternative 2 or 3 relative to Alternative 1 would be a low to moderately beneficial impact.

It is important to note that, in the modeling for this impact analysis, the abundance of species other than chinook salmon within the action area was held constant with the base period; that is, the “scenarios” used to simulate variability in abundance and fishing regimes outside the action area were not applied for these species.

4.3.2.1 Alternative 1 – Proposed Action/Status Quo

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 1, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 476,794 coho salmon, 92,850 sockeye salmon, 419,957 pink salmon, and 715,235 fall and winter chum salmon.

Under Alternative 1, escapement of naturally-spawning coho salmon is predicted to be 326,114 fish. As shown in Table 4.3-11, it is predicted that the co-managers' exploitation rate goals would be met under Alternative 1 for all Puget Sound coho salmon management units by margins ranging from 13 to 27 percent. An exploitation rate ceiling has not been established for South Puget Sound coho salmon, but the exploitation rate achieved under Alternative 1 would balance natural spawning capacity and hatchery program objectives.

Under Alternative 1, the escapement of Baker River sockeye salmon is predicted to exceed the goal by almost 300 percent. A recreational and tribal fishery for Cedar River sockeye salmon was modeled under Alternative 1 with a predicted total catch of 92,600 sockeye. Under this Alternative, escapement is predicted to be 17 percent below the goal for the Cedar River (Table 4.3-11).

The escapement of naturally-spawning pink salmon to streams in the seven management units is predicted to be 897,976 fish. Under Alternative 1, escapements of pink salmon are predicted to exceed the goal by a substantial margin for the Nooksack, Skagit, and Snohomish River pink salmon management units, and are predicted to be substantially below the goals for South Puget Sound and Hood Canal. A pink salmon escapement goal is not available for the Strait of Juan de Fuca management unit.

Table 4.3-11 Performance of Alternative 1 (Proposed Action) relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

						Performance vs Standards	
	Wild Exploitation Rate	Exploit. Rate Objective	Southern U.S. Catch	Natural Escapement	Escapement Goal	Exploitation Rate	Escapement
Coho							
Nooksack/Samish	50%	75%	41,215	8,182		-25%	
Skagit	37%	60%	42,493	73,624		-23%	
Stillaguamish	37%	50%	12,069	24,017		-13%	
Snohomish	33%	60%	76,720	136,873		-27%	
South Sound	55%		246,383	47,086			
Hood Canal	42%	65%	42,909	19,012		-23%	
Juan de Fuca	14%	40%	15,005	17,320		-26%	
All Coho			**476,794**	**326,114**			
Sockeye							
Skagit			250	11,823	3,000		294%
South Sound			92,600	291,916	350,000		-17%
All Sockeye			**92,850**	**303,739**			
Pink							
Nooksack/Samish	7%		7,184	91,988	50,000		84%
Skagit	30%		184,614	430,792	330,000		31%
Stillaguamish	36%		90,690	164,000	155,000		6%
Snohomish	37%		101,193	173,000	120,000		44%
South Sound	9%		1,319	13,283	25,000		-47%
Hood Canal	39%		33,467	20,065	125,000		-84%
Juan de Fuca	35%		1,490	4,848			
All Pink			**419,957**	**897,976**			
Fall Chum							
Nooksack/Samish	56%		54,738	35,610	20,800		71%
Skagit	9%		4,253	42,237	40,000		6%
Stillaguamish	59%		21,577	14,400	13,100		10%
Snohomish	51%		54,284	17,600	10,200		73%
South Sound	68%		361,258	150,923	64,350		135%
Hood Canal	49%		218,987	50,382	39,900		26%
Juan de Fuca	7%		137	2,585	3,600		-28%
All Fall Chum			**715,234**	**313,737**			

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Escapement of naturally-spawning fall and winter chum salmon to streams in the seven management units under Alternative 1 is predicted to be 313,737 fish. Under Alternative 1, escapement is predicted to meet the co-managers' escapement goals by substantial margins for the Nooksack, Snohomish, South Puget Sound, and Hood Canal chum salmon management units, and by low margins for the Skagit and Stillaguamish management units. Escapement of naturally-spawning fall and winter chum salmon is predicted to be substantially less than the goal for the Strait of Juan de Fuca Management Unit (see Table 4.3-11).

4.3.2.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Impacts to Unlisted Puget Sound Salmon Populations and Comparison to Alternative 1

Under Alternative 2, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 197,691 coho salmon, zero sockeye salmon, 115,732 pink salmon, and 152,384 fall and winter chum salmon.

As shown in Table 4.3-12a, the co-managers' exploitation rate goals are predicted to be met under Alternative 2 for all Puget Sound coho salmon management units by margins ranging from 26 to 62 percent. Exploitation rates on naturally-spawning coho salmon are predicted to be substantially lower than with Alternative 1, by margins ranging from 24 to 56 percent, while coho escapement is predicted to increase substantially, by margins ranging from 9 to 74 percent (see Table 4.3-12b).

With Alternative 2, Cedar River sockeye salmon fisheries would be closed, with the result that escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly over the goal of 300,000. Catch of Baker River sockeye is predicted to be zero. The predicted increase in Cedar River sockeye salmon escapement of approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye salmon would constitute a small (low) beneficial impact relative to Alternative 1. Harvest of Puget Sound pink salmon is predicted to decline by more than 339,000 compared to Alternative 1. Spawning escapement to the Nooksack and South Puget Sound management units is predicted to increase by a small margin and by a substantial margin (ranging from 22 to 58 percent) to the Skagit, Stillaguamish, Snohomish, Hood Canal, and Strait of Juan de Fuca units (Table 4.3-12b). As with Alternative 1, escapements are not predicted to meet the escapement goals for the South Sound and Hood Canal management units.

Table 4.3-12a Performance of Alternative 2 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

						Performance vs Standards:	
	Wild Exploitation Rate	Exploit. Rate Objective	Southern U.S. Catch	Natural Escapement	Escapement Goal	Exploitation Rate	Escapement
Coho							
Nooksack/Samish	13%	75%	7,386	14,272		-62%	
Skagit	6%	60%	5,019	109,887		-54%	
Stillaguamish	24%	50%	8,024	28,689		-26%	
Snohomish	19%	60%	47,594	165,820		-41%	
South Sound	33%		115,245	69,945			
Hood Canal	12%	65%	7,931	28,533		-53%	
Juan de Fuca	6%	40%	6,492	18,819		-34%	
All Coho			**197,691**	**435,965**			
Sockeye							
Skagit	0%		0	12,073	3,000		302%
South Sound	0%		0	362,292	350,000		4%
All Sockeye			**0**	**237,256**			
Pink							
Nooksack/Samish	0%		0	99,172	50,000		98%
Skagit	0%		0	615,406	330,000		86%
Stillaguamish	21%		54,331	200,360	155,000		29%
Snohomish	0%		34,800	274,192	120,000		128%
South Sound	4%		600	13,999	25,000		-44%
Hood Canal	16%		26,001	27,556	125,000		-78%
Juan de Fuca	15%		0	6,338			
All Pink			**115,732**	**1,237,023**			
Fall Chum							
Nooksack/Samish	1%		1,090	79,482	20,800		282%
Skagit	1%		252	46,071	40,000		15%
Stillaguamish	2%		852	34,194	13,100		161%
Snohomish	0%		239	35,583	10,200		249%
South Sound	16%		83,501	399,761	64,350		521%
Hood Canal	4%		66,448	95,473	39,900		139%
Juan de Fuca	2%		2	2,722	3,600		-24%
All Fall Chum			**152,384**	**693,286**			

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-12b Performance of Alternative 2 (Escapement goal management at the management unit level) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

	Changes Relative to Alternative 1						
	Wild Exploitation Rate	Southern U.S.Catch	Total Mortality	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Coho							
Nooksack/Samish	-37%	(33829)	(6,151)	6,090	74%	beneficial	substantial
Skagit	-31%	(37474)	(36,580)	36,263	49%	beneficial	substantial
Stillaguamish	-13%	(4045)	(4,782)	4,672	19%	beneficial	substantial
Snohomish	-14%	(29126)	(29,567)	28,947	21%	beneficial	substantial
South Sound	-22%	(131138)	(23,503)	22,859	49%	beneficial	substantial
Hood Canal	-30%	(34978)	(9,662)	9,521	50%	beneficial	substantial
Juan de Fuca	-8%	(8513)	(1,529)	1,499	9%	beneficial	low
All Coho		**(279103)**	**(111774)**	**109851**	34%		
Sockeye							
Skagit		(250)		250			
South Sound		(92600)		70,376			
All Sockeye		**(92850)**		**250**			
Pink							
Nooksack/Samish		(7184)	(7,184)	7,184	8%	beneficial	low
Skagit		(184614)	(184,611)	184,614	43%	beneficial	substantial
Stillaguamish		(36359)	(36,359)	36,360	22%	beneficial	substantial
Snohomish		(66393)	(101,192)	101,192	58%	beneficial	substantial
South Sound		(719)	(716)	716	5%	beneficial	low
Hood Canal		(7466)	(7,491)	7,491	37%	beneficial	substantial
Juan de Fuca		(1490)	(1,490)	1,490	31%	beneficial	substantial
All Pink		**(304225)**	**(339043)**	**339047**	38%		
Fall Chum							
Nooksack/Samish		(53648)	(43,872)	43,872	123%	beneficial	substantial
Skagit		(4001)	(3,834)	3,834	9%	beneficial	low
Stillaguamish		(20725)	(19,789)	19,794	137%	beneficial	substantial
Snohomish		(54045)	(17,983)	17,983	102%	beneficial	substantial
South Sound		(277757)	(248,838)	248,838	165%	beneficial	substantial
Hood Canal		(152539)	(45,091)	45,091	89%	beneficial	substantial
Juan de Fuca		(135)	(137)	137	5%	beneficial	low
All Fall Chum		**(562,850)**	**(379,544)**	**379,549**	121%		

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

Escapement of most naturally-spawning fall and winter chum salmon management units is predicted to increase by more than 100 percent compared to Alternative 1. As with Alternative 1, chum salmon escapement is predicted to meet the co-managers' escapement goals by substantial margins in all but the Skagit and Strait of Juan de Fuca chum salmon management units. The increase in escapement for the Skagit management unit is predicted to be low compared to Alternative 1, and the Strait of Juan de Fuca management unit is not predicted to meet its escapement goal.

Based on the expected increases in escapement of naturally-spawning fish that are predicted to occur under Alternative 2 relative to Alternative 1, the impacts of Alternative 2 to populations in the two sockeye salmon management units would be beneficial, but low. Impacts to all other populations of coho, fall and winter chum, and pink salmon are predicted to be moderately to substantially beneficial. However, as explained previously, for populations where escapements exceed current goals by substantial margins, the potential for density-dependent decreases in productivity due to competition for mates, food, or territory would be heightened; therefore, natural production by these populations is unlikely to increase in direct proportion to the predicted increase in spawning escapement.

4.3.2.3 Alternative 3 – Escapement Goal Management at the Population Level With Terminal Fisheries Only

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 3, the modeled total Southern U.S. catch of unlisted salmon species originating from Puget Sound is predicted to be 157,753 coho salmon, zero sockeye salmon, 26,601 pink salmon, and 151,578 fall and winter chum salmon.

As shown in Table 4.3-13a, the co-managers' exploitation rate goals are predicted to be met under Alternative 2 for all Puget Sound coho salmon management units by margins ranging from 34 to 62 percent. Exploitation rates on naturally-spawning coho salmon are predicted to be substantially lower than with Alternative 1, by margins ranging from 8 to 37 percent, while coho escapement is predicted to increase substantially, by margins ranging from 9 to 74 percent (see Table 4.3-13a).

Table 4.3-13a Performance of Alternative 3 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

						Performance vs Standards	
	Wild Exploitation Rate	Exploit. Rate Objective	Southern U.S. Catch	Natural Escapement	Escapement Goal	Exploitation Rate	Escapement
Coho							
Nooksack/Samish	13%	75%	7,386	14,272		-62%	
Skagit	6%	60%	5,019	109,887		-54%	
Stillaguamish	8%	50%	1,908	34,840		-42%	
Snohomish	8%	60%	13,772	187,066		-52%	
South Sound	33%		115,245	69,945			
Hood Canal	12%	65%	7,931	28,533		-53%	
Juan de Fuca	6%	40%	6,492	18,819		-34%	
All Coho			**157,753**	**463,362**			
Sockeye							
Skagit	0%		0	12,073	3,000		302%
South Sound	0%		0	224,422	350,000		-36%
All Sockeye				**236,495**			
Pink							
Nooksack/Samish	0%		0	99,172	50,000		98%
Skagit	0%		0	615,406	330,000		86%
Stillaguamish	0%		0	254,690	155,000		64%
Snohomish	0%		0	274,193	120,000		128%
South Sound	4%		600	13,999	25,000		-44%
Hood Canal	16%		26,001	27,556	125,000		-78%
Juan de Fuca	15%		0	6,338			
All Pink			**26,601**	**1,291,354**			
Fall Chum							
Nooksack/Samish	1%		1,090	79,482	20,800		282%
Skagit	1%		252	46,071	40,000		15%
Stillaguamish	0%		46	34,964	13,100		167%
Snohomish	0%		239	35,583	10,200		249%
South Sound	16%		83,501	399,761	64,350		521%
Hood Canal	4%		66,448	95,473	39,900		139%
Juan de Fuca	2%		2	2,722	3,600		-24%
All Fall Chum			**151,578**	**694,056**			

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

With Alternative 3, Cedar River sockeye salmon fisheries would be closed and escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly over the goal of 300,000 (Table 4.3-13a). Catch of Baker River sockeye is predicted to be zero. The predicted increase in Cedar River sockeye escapement by approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye would constitute a small (low) beneficial impact relative to Alternative 1 (Table 4.3-13b). Modeled harvest of Puget Sound pink salmon are predicted to decline by more than 393,000 compared to Alternative 1. Spawning escapement is predicted to increase by a small margin in the Skagit and South Puget Sound management units, and by a substantial margin (ranging from 89 to 143 percent) in other management units. As with Alternative 1, pink salmon escapements are not predicted to meet the escapement goals for the South Sound and Hood Canal management units.

Escapement of most naturally-spawning fall and winter chum salmon management units is predicted to increase by more than 100 percent compared to Alternative 1 (Table 4.3-13a). As with Alternative 1, chum salmon escapement is predicted to meet the co-managers' escapement goals by substantial margins in all but the Skagit and Strait of Juan de Fuca management units. The increase in escapement for the Skagit management unit is predicted to be low compared to Alternative 1, and the Strait of Juan de Fuca management unit is not predicted to meet its escapement goal (Table 4.3-13b).

Based on the predicted increases in escapement of naturally-spawning fish that would occur under Alternative 3 relative to Alternative 1, the impacts of Alternative 3 on populations in the two sockeye salmon management units would be beneficial, but low. Impacts to all other populations of coho salmon, fall-winter chum salmon, and pink salmon would be moderately to substantially beneficial. However, as explained previously, for populations where escapements exceed current goals by substantial margins, the potential for density-dependent declines in productivity based on competition for mates, food or territory would be heightened, with the result that natural production by these populations is unlikely to increase proportionate to the predicted increase in spawning escapement.

Table 4.3-13b Performance of Alternative 3 (Escapement goal management at the population level) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

	Changes Relative to Alternative 1						
	Wild Exploitation Rate	Southern U.S.Catch	Total Mortality	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Coho							
Nooksack/Samish	-37%	(33829)	(6,151)	6,090	74%	beneficial	substantial
Skagit	-31%	(37474)	(36,580)	36,263	49%	beneficial	substantial
Stillaguamish	-29%	(10161)	(10,969)	10,823	45%	beneficial	substantial
Snohomish	-25%	(62948)	(51,002)	50,193	37%	beneficial	substantial
South Sound	-22%	(131138)	(23,503)	22,859	49%	beneficial	substantial
Hood Canal	-30%	(34978)	(9,662)	9,521	50%	beneficial	substantial
Juan de Fuca	-8%	(8513)	(1,529)	1,499	9%	beneficial	low
All Coho		**(319041)**	**(139396)**	**137248**	42%		
Sockeye							
Skagit		(250)		250			
South Sound		(92600)		(67,494)			
All Sockeye		**(92850)**		**250**			
Pink							
Nooksack/Samish		(7184)	(7,184)	7,184	8%	beneficial	low
Skagit		(184614)	(184,611)	184,614	43%	beneficial	substantial
Stillaguamish		(90690)	(90,690)	90,690	55%	beneficial	substantial
Snohomish		(101193)	(101,192)	101,193	58%	beneficial	substantial
South Sound		(719)	(716)	716	5%	beneficial	low
Hood Canal		(7466)	(7,491)	7,491	37%	beneficial	substantial
Juan de Fuca		(1490)	(1,490)	1,490	31%	beneficial	substantial
All Pink		**(393356)**	**(393374)**	**393378**	44%		
Fall Chum							
Nooksack/Samish		(53648)	(43,872)	43,872	123%	beneficial	substantial
Skagit		(4001)	(3,834)	3,834	9%	beneficial	low
Stillaguamish		(21531)	(20,564)	20,564	143%	beneficial	substantial
Snohomish		(54045)	(17,983)	17,983	102%	beneficial	substantial
South Sound		(277757)	(248,838)	248,838	165%	beneficial	substantial
Hood Canal		(152539)	(45,091)	45,091	89%	beneficial	substantial
Juan de Fuca		(135)	(137)	137	5%	beneficial	low
All Fall Chum		**(563,656)**	**(380,319)**	**380,319**	121%		

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

4.3.2.4 Alternative 4 – No Action/No Authorized Take

Impacts to Unlisted Puget Sound Salmon Populations

Under Alternative 4, the modeled Southern U.S. catch of unlisted salmon species originating from Puget Sound is 70,260 coho salmon, zero sockeye salmon, 6,459 pink salmon, and 38,877 fall and winter chum salmon. The predicted catch would be the same under all scenarios.

Under Alternative 4, the No Authorized Take alternative, catch of unlisted salmonids would be limited to terminal areas when naturally-spawning chinook salmon are absent. The effect of Alternative 4 is predicted to be a further reduction in catch and exploitation rates, with further increases in escapement of both natural- and hatchery-origin salmonids compared to Alternative 2 or 3. The exploitation rates on coho salmon populations are predicted to decline to 6 to 8 percent. These rates are predicted to be lower than with Alternative 1 by substantial margins (25 to 49%) (Table 4.3-14b). Spawning escapement is predicted to increase substantially (by 168,000 for all management units) relative to Alternative 1. Exploitation rate goals are predicted to be met for all management units, by margins ranging from 34 to 68 percent (see Table 4.3-14a). With Alternative 4, Cedar River sockeye salmon fisheries would be closed and escapement is predicted to increase by approximately 92,600 fish, bringing escapement to slightly more than the goal of 300,000. Baker River sockeye salmon catch is predicted to be zero. The predicted increase in Cedar River sockeye escapement by approximately 24 percent would constitute a moderate beneficial impact. The increased escapement of Baker River sockeye would constitute a small (low) beneficial impact relative to Alternative 1.

Under Alternative 4, exploitation rates in Puget Sound fisheries for pink salmon are predicted to be zero for the Nooksack, Skagit, Stillaguamish, Snohomish, and South Puget Sound management units. Spawning escapement is predicted to increase by a low amount for the Nooksack and South Sound management units, and substantially for the Skagit, Stillaguamish, Snohomish, Hood Canal, and Strait of Juan de Fuca management units, compared to the outcome of Alternative 1 (Table 4.3-14b). As with Alternative 2 or 3, it is predicted that escapement goals for pink salmon would be substantially exceeded. Also as with Alternative 2 or 3, although escapements would increase for the South Puget Sound and Hood Canal pink salmon management units, the escapement goals still would not be met.

Table 4.3-14a Performance of Alternative 4 relative to exploitation rate objectives or escapement goals for coho, sockeye, pink, and fall-winter chum salmon.

	Wild Exploitation Rate	Exploit. Rate Objective	Southern U.S. Catch	Natural Escapement	Escapement Goal	Performance vs Standards: Exploitation Rate	Performance vs Standards: Escapement
Coho							
Nooksack/Samish	7%	75%	2,463	15,305		-68%	
Skagit	6%	60%	6,409	110,022		-54%	
Stillaguamish	8%	50%	5,205	34,840		-42%	
Snohomish	8%	60%	1,910	187,066		-52%	
South Sound	6%		13,784	97,804			
Hood Canal	7%	65%	33,886	30,345		-58%	
Juan de Fuca	6%	40%	6,603	18,819		-34%	
All Coho			**70,260**	**494,201**			
Sockeye							
Skagit	0%		0	12,073	3,000		302%
South Sound	0%		0	224,422	350,000		-36%
All Sockeye				**236,495**			
Pink							
Nooksack/Samish	0%		0	99,172	50,000		98%
Skagit	0%		0	615,406	330,000		86%
Stillaguamish	0%		0	254,690	155,000		64%
Snohomish	0%		0	274,193	120,000		128%
South Sound				14,596	25,000		-42%
Hood Canal	10%		6,459	47,387	125,000		-62%
Juan de Fuca	15%		0	6,338			
All Pink			**6,459**	**1,311,782**			
Fall Chum							
Nooksack/Samish	1%		1,066	79,501	20,800		282%
Skagit	1%		252	46,071	40,000		15%
Stillaguamish	0%		46	34,964	13,100		167%
Snohomish	0%		239	35,583	10,200		249%
South Sound	7%		36,912	441,499	64,350		586%
Hood Canal			360	99,621	39,900		150%
Juan de Fuca	2%		2	2,722	3,600		-24%
All Fall Chum			**38,877**	**739,961**			

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003.

Table 4.3-14b Performance of Alternative 4 (No Fishing) relative to Alternative 1 for coho, sockeye, pink, and chum salmon.

	Changes Relative to Alternative 1						
	Wild Exploitation Rate	Southern U.S.Catch	Total Mortality	Natural Escapement	% Change Escapement	Type of Impact	Magnitude of Impact
Coho							
Nooksack/Samish	-43%	(38752)	(7,185)	7,123	87%	beneficial	substantial
Skagit	-31%	(36084)	(36,715)	36,398	49%	beneficial	substantial
Stillaguamish	-29%	(6864)	(10,969)	10,823	45%	beneficial	substantial
Snohomish	-25%	(74810)	(51,002)	50,193	37%	beneficial	substantial
South Sound	-49%	(232599)	(51,361)	50,718	108%	beneficial	substantial
Hood Canal	-35%	(9023)	(11,473)	11,333	60%	beneficial	substantial
Juan de Fuca	-8%	(8402)	(1,529)	1,499	9%	beneficial	low
All Coho		**(406534)**	**(170234)**	**168087**	52%		
Sockeye							
Skagit		(250)		250			
South Sound		(92600)		(67,494)			
All Sockeye		**(92850)**		**250**			
Pink							
Nooksack/Samish		(7184)	(7,184)	7,184	8%	beneficial	low
Skagit		(184614)	(184,611)	184,614	43%	beneficial	substantial
Stillaguamish		(90690)	(90,690)	90,690	55%	beneficial	substantial
Snohomish		(101193)	(101,192)	101,193	58%	beneficial	substantial
South Sound		(1319)	(1,313)	1,313	10%	beneficial	low
Hood Canal		(27008)	(7,597)	27,322	136%	beneficial	substantial
Juan de Fuca		(1490)	(1,490)	1,490	31%	beneficial	substantial
All Pink		**(413498)**	**(394077)**	**413806**	46%		
Fall Chum							
Nooksack/Samish		(53672)	(43,891)	43,891	123%	beneficial	substantial
Skagit		(4001)	(3,834)	3,834	9%	beneficial	low
Stillaguamish		(21531)	(20,564)	20,564	143%	beneficial	substantial
Snohomish		(54045)	(17,983)	17,983	102%	beneficial	substantial
South Sound		(324346)	(290,576)	290,576	193%	beneficial	substantial
Hood Canal		(218627)	(49,240)	49,239	98%	beneficial	substantial
Juan de Fuca		(135)	(137)	137	5%	beneficial	low
All Fall Chum		**(676,357)**	**(426,225)**	**426,224**	136%		

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, December 2003

Fall and winter chum salmon harvest under Alternative 4 is predicted to be about 39,000, a decrease relative to Alternative 1 of 676,357. Escapements of naturally-spawning fall and winter chum salmon are predicted to increase substantially – by 426,224 fish under Alternative 4, or more than 100 percent of the escapement goals for the Nooksack, Stillaguamish, Snohomish, Mid-Hood Canal, and South Puget Sound units. However, it is predicted that the escapement goal for the Strait of Juan de Fuca unit, for which the run size entering Puget Sound is predicted to be below the escapement goal, would not be achieved (see Table 4.3-14b).

Based on the predicted increases in escapement of naturally-spawning fish that would occur under Alternative 4 relative to Alternative 1, the impact of Alternative 4 on escapements of sockeye salmon, Nooksack-Samish and South Sound pink salmon, and Skagit and Strait of Juan de Fuca chum salmon are predicted to be beneficial, but of low magnitude. Impacts to all other populations of coho, fall-winter chum, and pink salmon are predicted to be substantially beneficial. However, as discussed above, escapement far in excess of current escapement goals raises the potential of intra- and inter-specific density-dependent reductions in productivity due to competition for mates, food or territory. For many coho salmon management units, exploitation rate objectives are based on stock recruit functions which would predict that large increases in escapement would not result in substantial increases in progeny (personal communication via e-mail from William Beattie, Northwest Indian Fisheries Commission, Conservation Management Coordinator, to The William Douglas Company, February 17, 2004).

4.3.3 Non-Salmonid Fish Species

Unlisted non-salmonid fish species potentially affected by the Proposed Action include the groundfish and forage fish species discussed in Subsections 3.3.3, Non-Salmonid Fishes (Groundfish): Affected Environment, and 3.3.4, Forage Species (Pacific Herring, Sandlance, Smelt): Affected Environment. Impacts of the Proposed Action or alternatives to groundfish species would result from changes in the incidental catch of these species in marine salmon fisheries. Impacts to forage fish species would be related to possible changes in the predator-prey relationship resulting from changes in the marine abundance of salmon.

According to Palsson (2002), marine salmon anglers take approximately 0.65 groundfish per trip. Therefore, with Alternative 1, the incidental catch of groundfish species in sport salmon fisheries is predicted to be approximately 241,765 groundfish, based on the area-wide average catch per trip. Species comprising the recreational catch include Pacific halibut, other flatfish, lingcod, rockfish

(*Sebastes spp.),* Pacific cod, and dogfish, but the species composition of groundfish caught incidentally during salmon fishing has not been quantified. Under Alternative 1, it is likely that sportfishing effort would vary somewhat under the different scenarios, but it is difficult to predict how that variability would affect the incidental catch of groundfish.

Under Alternative 2, 3, or 4 there would be no marine sport fisheries in Puget Sound, so incidental catch of groundfish would be reduced by 100 percent with either of these alternatives. As discussed in Subsection 3.3.3, commercial fisheries targeting salmon attempt to avoid incidental harvest of groundfish species, and landings of groundfish species in commercial salmon fisheries are rarely reported.

Under Alternative 2, most commercial salmon fisheries in marine areas would be closed (the marine fisheries that would occur under Alternative 2 are nearshore using beach seines or set gillnets and therefore are anticipated to have a negligible impact on groundfish), and under Alternative 3 or 4, all commercial salmon fisheries in marine areas would be closed. Therefore, incidental catch of groundfish under either of these alternatives would be eliminated relative to Alternative 1. This would represent a substantial beneficial impact to these species. Chinook and coho salmon are key predators of sandlance, herring, and smelt, the predominant forage fish species present in Puget Sound. Sockeye, chum and pink salmon, particularly as juveniles, feed predominately on small, free-swimming crustacea, but adults occasionally feed on forage fish species. The direct impacts of the Proposed Action or alternatives would be related to reductions in catch under Alternative 2, 3, or 4 that would potentially increase predation by adult salmon on these forage fish species during the period in which fisheries would otherwise take place. Other effects would be indirect in nature, and are discussed below in Subsection 4.3.8, Indirect and Cumulative Effects.

4.3.4 Fish Habitat

The primary impacts of salmon fisheries on fish habitat occur as a result of tribal and sport fisheries in river areas, and include disruptions of spawning beds by wading fishermen and boat traffic, and, to a lesser extent, degradation of streamside habitat. As required by the Magnuson-Steven's Conservation and Management Act, NMFS conducted an essential fish habitat (EFH) consultation on the 2003 4(d) determination and concluded that Alternative 1 (the Proposed Action) would not adversely affect designated EFH for chinook salmon. NMFS is currently conducting an EFH consultation on the ~~2004~~ 2005–~~–~~2009 4(d) determination that will be complete for the Final Environmental Impact Statement. However, since the anticipated fishery structure of the Proposed Action is similar to that of the 2003 fisheries Resource Management Plan, the effects on EFH are also likely to be similar. Therefore, at this time, NMFS does not anticipate Alternative 1 will adversely affect designated EFH. Fisheries modeled under Alternatives 2 and 3 are predicted to increase the level of fishing effort in freshwater areas and, potentially, would result in a possible low adverse impact on fish habitat. Fisheries modeled under Alternative 4 are predicted to decrease fishing effort in freshwater areas relative to Alternative 1, and are therefore predicted to eliminate the potential impact to fish habitat from these sources and would thus be considered to have a no to low beneficial impact. However, regardless of the alternative considered, these effects would occur to some degree through the occurrence of fisheries other than those addressed in Alternative 1 (the Proposed Action); e.g., recreational freshwater trout or steelhead fisheries, that do not take listed Puget Sound salmon species.

4.3.5 Marine-Derived Nutrients from Spawning Salmon

The input of nutrients into freshwater systems associated with the return of adult salmon is, at the simplest level, directly related to the biomass of spawners of all species. However, as described in Affected Environment (Subsection 3.3.6, Marine-Derived Nutrients from Spawning Salmon), the processes by which juvenile chinook and other species benefit directly and indirectly from this source of nutrients comprise a highly complex transport web.

~~Nutrients provided by adult salmon to freshwater systems are, at the simplest level, directly related to the biomass of spawners of all species. However, as described in the Affected Environment (Subsection 3.3.5, Marine-Derived Nutrients from Spawning Salmon), highly complex processes determine how juvenile chinook salmon and other species benefit directly and indirectly from this source of nutrients.~~

This subsection refers to the modeled spawning escapement of all salmon species, converted to carcass biomass predicted to result from implementation of the Proposed Action or alternative harvest management regimes, and assesses the nutrient-related effects on the production and survival of juvenile chinook. At the current state of scientific inquiry in this field, variability in the factors affecting salmon-derived nutrient loading; and the state of technical tools necessary to quantify nutrient loading, it is not possible to quantify nutrient loading in any one Puget Sound river system, or to measure the differences in growth and survival of juvenile chinook in a system that would result from different spawner abundance of all salmon species.

~~in any one Puget Sound river system, or the differences in growth and survival of juvenile chinook in a system that would result from different spawner abundance of all salmon species, are not available.~~

~~Nutrient loading is affected by spawner density, which varies greatly among species and river reaches, and by stream flow, water temperature, stream channel structure, and a multitude of other factors that affect carcass and nutrient availability, decomposition, and retention (see Subsection 3.3.5, Marine-Derived Nutrients from Spawning Salmon: Affected Environment).~~

The following analysis compares adult salmonid escapement and spawner biomass among alternatives for Scenario B, because this scenario is the most likely combination of chinook abundance and fisheries to occur over the duration of the Proposed Action. The variability in escapement associated with the other Canadian/Alaskan fishery and abundance scenarios (A, C, or D) is noted, but does not influence the relative magnitude of the potential impact of the alternatives.

It must be noted that added nutrients, above current levels, may not be desirable in all streams. The Washington Department of Ecology reports that more than 2,600 bodies of water throughout Washington are listed under Section 303(d) of the Clean Water Act as Category 5, “polluted.” For those waters, and others with lesser water quality problems, increased nutrient loads may not provide a benefit to fish and wildlife. Lackey (2003) reminds us that federal and state legislation has, for many years, focused on reducing the nutrient and toxic pollutant input associated with human development, so intentionally managing salmonids to increase nutrient input has complex implications for public policy.

4.3.5.1 Alternative 1 – Proposed Action/Status Quo

To compare the consequences of the Proposed Action or alternatives, the biomass of spawning salmon is compared for ~~four~~ three river systems – the Skagit River, Snohomish River, and Stillaguamish River~~, and the Green-Duwamish River~~. These systems offer examples that contrast the variation in total spawner biomass in different systems, and the contribution of chinook salmon to total spawner biomass. For this analysis, biomass was approximated from modeled escapements and average weights for each species (i.e., 15 pounds for chinook, 12 pounds for chum, 6 pounds for coho, and 4 pounds for pink salmon) (personal communication with Robert Hayman, Skagit Systems Cooperative, Salmon Recovery Biologist, August 19, 1999). Sockeye salmon are not included in this accounting, because they spawn only in the Baker River drainage of the Skagit basin and in the Cedar River (Lake Washington system), and therefore are not broadly representative of the species composition in Puget Sound watersheds with spawning salmon. Salmon escapement in other river systems in Puget Sound varies from that in the three example watersheds. Pink salmon are not generally abundance, except in the Nooksack River, and recently in the Green River, whereas chum salmon are widely distributed and spawn in large and small river and stream systems.

Under Alternative 1, the co-managers’ proposed harvest plan, total spawner biomass is projected to exceed 2.86 million pounds in the Skagit River system, 1.80 million pounds in the Snohomish River system, and 1.01~~0~~ million pounds in the Stillaguamish River system~~, and 0.15 million pounds in the Green-Duwamish River system~~ (Table 4.3.5-1). In the Skagit, Stillaguamish, and Snohomish River systems, chinook salmon contribute a small proportion (i.e., 4% to 7%) of the total biomass, while coho, pink, and chum salmon each comprise much larger proportions. ~~By contrast, in the Green-Duwamish River, coho and chum salmon escapement is relatively low, but chinook salmon comprise 59 percent of total spawner biomass.~~ Hatchery-origin chinook salmon comprise a relatively small proportion of chinook salmon escapement ~~to~~in the Skagit~~, Stillaguamish,~~ and Snohomish River systems~~, but a large proportion of chinook salmon escapement to the Green-Duwamish River system,~~ but have contributed up to 55 percent in the North Fork of the Stillaguamish River. Chinook spawning escapement is predicted to vary from 3 percent higher to 24 percent lower than Scenario B[xiii], if abundance and Canadian/Alaskan fisheries varies as specified in Scenarios A, C, or D. Total spawning escapement would also vary with changes in overall abundance and Canadian/Alaskan fisheries harvest levels, but information is not currently available to quantify the amount.

Table 4.3.5-1 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ ~~r~~Stillaguamish Rivers, under Alternative 1.

	Chinook	Coho	Pink	Chum	Total
Skagit	193,104	441,744	1,723,168	506,840	2,864,856
Snohomish	73,511	821,238	692,000	211,200	1,797,949
Stillaguamish	34,215	144,102	656,000	172,800	1,007,117

~~Chinook~~	~~Coho~~	~~Pink~~	~~Chum~~	~~Total~~
~~203,310~~	~~441,744~~	~~1,723,168~~	~~506,840~~	~~2,875,061~~
~~76,089~~	~~821,238~~	~~692,000~~	~~211,200~~	~~1,800,527~~
~~87,285~~	~~42,377~~	~~0~~	~~18,111~~	~~147,773~~
~~34,830~~	~~144,102~~	~~656,000~~	~~172,800~~	~~1,007,732~~

The extent to which these escapements promote or constrain the productivity of natural chinook salmon populations cannot be quantified, due to factors discussed above and the lack of basin-specific empirical understanding of the relationship between escapement, nutrient loading, and salmon productivity. Intuitively, any factor that increases the growth rate of juvenile chinook salmon could, potentially, increase their survival through their freshwater, estuarine, and early marine life stages, but this effect has not been empirically demonstrated for Puget Sound chinook. Chinook populations that characteristically produce high proportions of yearling smolts will be more likely to benefit, given their

[xiii] Spawning escapements projected to occur under Alternative 1 may vary substantially from the example provided above for some systems in some years. In the Skagit system, for example, total spawner biomass ranged from 1.0 to 5.2 million pounds in 1998 – 2002 (personal communication with Robert Hayman, Skagit River System Cooperative, August 2003). Units for which harvest is managed under exploitation rate objectives are predicted to experience variable escapement, increasing or decreasing in direct relation to total abundance. For some units managed under escapement goals, recent experience suggests that escapement may also exceed goals depending on abundance, but less so than under exploitation rate management since all abundance above the goal is considered available for harvest.

extended freshwater residence, as is predicted to juvenile coho salmon and steelhead, all of which reside in freshwater for more than one year before smolting. However, ocean-type chinook populations, and pink and chum salmon, might also benefit from increased nutrient loading, particularly if it increases prey availability in estuarine areas.

If nutrient loading currently imposes a primary constraint on juvenile salmon survival, then the consequences of Alternative 1 are predicted to maintain the status quo in this regard. If production and availability of the ~~Nutrient-related constraint of productivity rests on the assumption that the~~ preferred prey of juvenile coho salmon is limited by current nutrient loading from salmon carcasses~~such that, at some point in their early life history~~, the growth and survival of juvenile salmon is reduced under current conditions. This hypothesis is supported for some salmon species by numerous studies that consistently show increased growth rates among juvenile coho and steelhead when carcass loading is increased (Bilby et al. 1998; and Wipfli et al. 1999). However, information is insufficient to identify in which populations of Puget Sound chinook, or other salmon species, survival might be affected.

If habitat conditions or other physical and biotic factors currently limit survival, maintaining recent escapements will have little or no effect on chinook productivity. For example, circumstantial evidence suggests this is the case in the Skagit River. The magnitude of peak river flow during the chinook incubation period, presumably due to increased risk of scour and sediment deposition in spawning areas, has correlated very closely with ~~Age-0~~ chinook smolt production (Seiler et al. 2002 and 2000). There is no odd-even year pattern of chinook smolt abundance or survival rate, as is predicted to be expected if the observed variation in pink salmon carcass loading affected chinook survival. Though such an effect is predicted to be statistically difficult to detect, given the overwhelming influence of incubation period flow, there is no significant correlation between chinook salmon smolt abundance and escapement of other species, even when the effects of flow are taken into account (personal communication with Robert Hayman, Skagit River System Cooperative, Salmon Recovery Planner, August 19, 1999).

This hypothesis will continue to be tested when the productivity of systems in which salmon escapement has recently increased substantially is reassessed. Under Alternative 1, such monitoring is required, and adjustment of management objectives is mandated, if studies determine that the productivity of chinook or other salmon species is nutrient-limited.

Implementation of Alternative 1 would also maintain current conditions among the wide variety of other aquatic and terrestrial species that feed directly on carcasses or utilize marine derived nutrients. Because the abundance of returning salmon varies annually, their potential nutrient contribution will also vary over the short term from the baseline level examined in this assessment. Direct consumers of carcasses – aquatic invertebrates, fish, mammals, and birds – will experience this annual fluctuation in abundance, whereas indirect plant or animal consumers will be less affected because these nutrients are stored and re-cycled within the local trophic web. This assessment cannot practically examine the range of possible effects of Alternative 1 on all fish and wildlife species that utilize marine derived nutrition. Ignoring, for the moment, the likelihood of annual variation in salmon escapement, the current level of carcass nutrient will persist under Alternative 1, so major changes in the distribution and abundance of consumer species is not anticipated.

4.3.5.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, Scenario B, total salmon spawner biomass is predicted to be 3.91 million pounds in the Skagit River (37~~6~~% higher than with Alternative 1), 1.84 million pounds in the Snohomish system (2% higher than with Alternative 1), and 1.40 million pounds in the Stillaguamish River system (39% higher than with Alternative 1)~~, and 0.20 million pounds in the Green-Duwamish River system (34% higher than with Alternative 1)~~ (Table 4.3.5-2)[xiv].

Assuming no scouring floods and sufficient carcass retention time, a broader distribution of carcasses throughout the river system might enhance primary and secondary ~~local~~ production (e.g., increase the production of aquatic algae, some riparian plant species, and invertebrate consumers at lower trophic levels)~~vity~~. Detailed analysis of spawner distribution is not available for this assessment; however, it may be possible that the predominant abundance of pink and chum spawners is predicted to be sufficient to supply the nutrients essential to the production of salmon prey species. This assumes that the carcasses are retained, and that marine-derived nutrients drive production of prey in habitat that is utilized by juvenile chinook salmon. However, increase in spawner abundance~~presence of carcasses~~, and resultant higher productivity, might ~~be inhibited by~~not result in higher survival of juvenile salmon if other habitat factors, such as incubation period flows or the availability of suitable spawning or rearing habitat limits survival. If, on the other hand, habitat is not limiting, Alternative 2 could have a beneficial effect on nutrient loading and subsequent production. ~~Therefore, a~~Although spawner biomass is predicted to be substantially higher with Alternative 2 compared to Alternative 1 for all~~ of~~

[xiv] Note, however, that these increases in total spawner biomass, comprise fewer spawners of some species (e.g., fewer chinook and/or coho in the Stillaguamish and Snohomish systems). Because species are distributed differently in the watersheds, their nutrient inputs, and effects, will not be equal, pound for pound.

three ~~the four~~ of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-2 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ Stillaguamish ~~r~~Rivers, under Alternative 2.

	Chinook	Coho	Pink	Chum	Total
Skagit	239,163	659,322	2,461,623	552,851	3,912,959
Snohomish	69,046	244,914	1,096,771	426,993	1,837,725
Stillaguamish	13,560	172,134	801,439	410,333	1,397,467

~~Chinook~~	~~Coho~~	~~Pink~~	~~Chum~~	~~Total~~
~~250,956~~	~~659,322~~	~~2,461,623~~	~~552,851~~	~~3,924,752~~
~~82,123~~	~~1,122,396~~	~~1,096,771~~	~~426,993~~	~~2,728,284~~
~~87,000~~	~~62,951~~	~~0~~	~~47,971~~	~~197,922~~
~~37,020~~	~~209,040~~	~~1,018,762~~	~~419,565~~	~~1,684,387~~

For chinook salmon populations that would be managed under exploitation rate objectives with Alternative 1 (i.e., the Skagit, Stillaguamish, and Snohomish management units), changing to escapement goal management is predicted to result in more stable numbers of spawners, provided that these goals were consistently achieved. This outcome is predicted to depend on accurate forecasting methods and low management error (see Subsection 4.3.8, Indirect and Cumulative Effects). The objectives for populations for which harvest is already managed to achieve escapement goals is predicted to not change with Alternative 2, but under the Puget Sound chinook abundance scenarios considered by this review, escapement goal management is predicted to virtually preclude marine harvest. Spawning escapement relative to Alternative 1 is predicted to increase as a result, particularly where terminal fisheries could not completely harvest the surplus of all species.

The abundance and production of other aquatic and terrestrial species that feed directly on salmon carcasses and eggs, or utilize marine-derived nutrients, is likely to increase under Alternative 2. Higher spawner abundance will increase the local abundance of avian and mammalian predators, as they are attracted to spawning streams. Many studies (see Subsection 3.3.6) indicate that production of aquatic invertebrates will increase, and provide more food for their predators. Effects could be manifest as increased over-winter survival and increased productivity in subsequent years for many species. Quantifying these effects is not possible in this assessment, because baseline abundance and production, or increase, has not been measured at the watershed or population scale for affected species. Again, this conclusion rests on the assumption that other environmental factors not constraining their survival and production.

4.3.5.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

The spawning biomass for all species of salmon, and resultant nutrient loading, is predicted to increase substantially relative to Alternative 1, if Alternative 3 were implemented. Under Alternative 3, total biomass of spawning salmon is predicted to be 3.91 million pounds, or 36 percent higher in the Skagit River system~~,~~, 2.73 million pounds or 52 percent higher in the Snohomish River system, and 1.68 million pounds, or 67 percent higher in the Stillaguamish River system~~, and 34 percent higher in the Green-Duwamish River system~~, relative to Alternative 1 (Table 4.3.5-3). ~~As with Alternative 2,~~T~~ the contribution of chinook salmon to total nutrient loading is predicted to be slightly less than with Alternative 1, because the virtual closure of all marine-area fisheries is predicted to result in proportionately greater escapement of other species~~hese total biomass estimates comprise higher escapement levels of all species in each of the three example rivers than under Alternative 1, but particularly higher abundance of coho, pink and chum salmon.

The effect of the projected increase in total salmon escapement on the productivity of chinook or other salmon species in these example systems, or within the Puget Sound ESU in general, cannot be quantified with current information due to the degree of variability in the environmental factors discussed above. As described above, juvenile chinook salmon with extended freshwater rearing (particularly those that smolt as yearlings) are predicted to be more likely to benefit from Alternative 3. But the nutrient loading (i.e., carcass density) thresholds necessary to support optimal primary and secondary productivity have not been determined for any Puget Sound basin. Therefore, the consequences to individual populations of implementing Alternative 3 are unknown, and are predicted to vary among different river systems. Also, if current habitat conditions create a primary constraint on system capacity and productivity, any beneficial effects of increased spawner abundance and nutrient loading may be offset by increased competition for suitable spawning habitat, redd superimposition, or overcrowding of rearing habitat. If, on the other hand, habitat is not limiting, Alternative 3 could have a beneficial effect on nutrient loading and subsequent production. Therefore, although spawner biomass is predicted to be substantially higher compared to Alternative 1 for all~~ four~~ three of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-3 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ Stillaguamish ~~r~~Rivers, under Alternative 3.

	Chinook	Coho	Pink	Chum	Total
Skagit	239,182	659,322	2,461,623	552,851	3,912,978
Snohomish	80,514	1,122,396	1,096,771	426,993	2,726,675
Stillaguamish	36,690	209,040	1,018,762	419,565	1,684,057

The beneficial effects of implementing Alternative 3 on other aquatic and terrestrial species cannot be quantified, but the qualitative effects, discussed under Alternative 2 above, might also result under Alternative 3.

~~Chinook~~	~~Coho~~	~~Pink~~	~~Chum~~	~~Total~~
~~250,937~~	~~659,322~~	~~2,461,623~~	~~552,851~~	~~3,924,734~~
~~69,514~~	~~244,914~~	~~1,096,771~~	~~426,993~~	~~1,838,192~~
~~87,000~~	~~62,951~~	~~0~~	~~47,971~~	~~197,922~~

~~13,545~~	~~172,134~~	~~801,439~~	~~410,333~~	~~1,397,452~~

4.3.5.4 Alternative 4 – No Action/No Authorized Take

Preclusion of all fisheries that harvest listed chinook salmon, as envisioned under Alternative 4, is predicted to result in substantially higher spawning escapement of all salmon species, and possibly substantially higher nutrient loading than is predicted to occur with Alternative 1. Total spawner biomass in the three example river systems is predicted to be virtually identical to that predicted under Alternative 3, i.e., 37 percent higher in the Skagit River system, 52 percent higher in the Snohomish River system, and 67 percent higher in the Stillaguamish River system~~, and 98 percent higher in the Green-Duwamish River system~~, compared to Alternative 1 (Table 4.3.5-4).

As noted in the preceding discussion, the effects of higher spawner biomass cannot be assumed to increase the productivity of chinook or other salmon species. Increases in productivity are predicted to be expected where nutrient input now limits prey availability, with consequent effect on the growth and survival of juvenile salmon. Increase in survival is predicted to only be realized if other habitat constraints on survival were addressed. Competition for suitable spawning areas, and other density-dependent factors may also counteract the potential nutrient-related benefit to growth and survival of juvenile chinook salmon. Therefore, although spawner biomass is predicted to be substantially higher with Alternative 4 compared to Alternative 1 for all ~~four~~ three of the example systems, it is not possible for these reasons to predict the difference in effects on the productivity of chinook salmon or other species.

Table 4.3.5-4 Biomass (pounds) of spawning salmon in the Skagit, Snohomish, and ~~Green~~ ~~r~~Stillaguamish Rivers, under Alternative 4.

	Chinook	Coho	Pink	Chum	Total
Skagit	239,182	660,132	2,461,623	552,851	3,913,788
Snohomish	80,514	1,122,396	1,096,771	426,993	2,726,675
Stillaguamish	36,690	209,040	1,018,762	419,565	1,684,057

~~Chinook~~	~~Coho~~	~~Pink~~	~~Chum~~	~~Total~~
~~250,956~~	~~660,132~~	~~2,461,623~~	~~552,851~~	~~3,925,562~~
~~82,562~~	~~1,122,396~~	~~1,096,771~~	~~426,993~~	~~2,728,723~~
~~158,370~~	~~88,024~~	~~0~~	~~52,980~~	~~299,374~~
~~37,020~~	~~209,040~~	~~1,018,762~~	~~419,565~~	~~1,684,387~~

4.3.6 Selectivity on Biological Characteristics of Salmon

Puget Sound fisheries regimes would vary substantially between the Proposed Action and alternatives considered in this Environmental Assessment, with respect to their selective effects on target species. This section qualitatively compares their effects, focusing on chinook salmon since that is the subject of the Proposed Action. It must be stated at the outset that a quantitative or theoretical analysis of the selective effects of current or historical fishing regimes has not been done in Puget Sound, except on a limited basis (Hard 2004 and as described in Subsection 3.3.7). As described in the Affected Environment (Subsection 3.3.7), long-time series of data describing the age composition and size of chinook salmon in catch and on the spawning grounds exist for many Puget Sound chinook salmon populations. However, the quality of the data vary greatly from population to population. Better data generally exist for returns to hatcheries. The causes for observed variation or trends in these biological characteristics are highly complex and confounded with each other, as discussed in Subsection 3.3.7. Although there is some indication that fisheries may be responsible for some proportion of the trends in size-at-age observed for some Puget Sound chinook populations, ~~T~~the influence of fisheries selectivity on variation and trends cannot be isolated from environmental and other causes. Furthermore, historical data reflect a constantly-changing fishing regime in fisheries inside and outside of Washington, particularly during the last decade (1991–2001). The selective effects of historically higher fishing pressure, for all gear types, are likely to have declined substantially as exploitation rates on Puget Sound chinook salmon have fallen (PSIT and Washington Department of Fish and Wildlife 2004). The relative harvest rates exerted by different gear types, and the distribution of effort by different gear types, have changed dramatically over the last 30 years. Furthermore, fishing regimes like those envisioned under Alternative 2 or 3 have never existed in Puget Sound, so their effects are necessarily a matter of conjecture.

Review of the scientific literature (discussed in Subsection 3.3.7) suggests that Puget Sound fisheries would exert some degree of selectivity on the size- or age-composition of chinook salmon, but available data do not indicate any changes or trends in the age composition of catch or escapement over the last several decades. As discussed in Subsection 3.3.7, the available data suggests that fisheries may exert some selective effects on some Puget Sound chinook populations, but do not indicate significant declines in size-at-age in the natural components of populations with moderate to high exploitation rates as might be expected. Hard (2004) concluded that selective effects over a 25 year period would be negligible or low at harvest rates less than approximately 40 percent. Further simulation with available data suggests that even for the hatchery components of populations with exploitation rates in excess of

50 percent and observed declines in size-at-age for ages most vulnerable to selective fishing effects, fisheries generally explain only a modest fraction of the observed trends (see Subsection 3.3.7). Exploitation rates on most chinook salmon populations associated with Puget Sound fisheries during the ~~period 2004~~ 2005–2009 fishing seasons are projected to fall well below this level in fishing regimes examined in this Environmental Impact Statement. The potential selective effects of fisheries will continue to be re-examined on a regular basis as part of the monitoring, evaluation, and adaptive management provisions of the Proposed Action or alternatives.

Since the pattern of exploitation rates across alternatives is similar for each scenario and cannot be quantitatively related to changes in size or age except on a very gross scale, the results have been combined across scenarios and are presented only by alternative for the purposes of the selective effects discussion.

4.3.6.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action represents a diverse spatial and temporal array of commercial net and recreational hook-and-line fisheries in marine and freshwater areas of Puget Sound. Some net fisheries would operate in the Strait of Juan de Fuca, Rosario Strait, and the Strait of Georgia, where stocks originating in Puget Sound and British Columbia commingle. These fisheries target sockeye, pink, and chum salmon, and harvest relatively few chinook salmon. Non-treaty purse seine vessels are required to release chinook salmon, and seines are designed to reduce the catch of immature chinook. In aggregate, these fisheries are likely to exert relatively low selective effects on chinook salmon.

Gillnet fisheries predominate commercial harvest of chinook salmon in other marine and freshwater areas in Puget Sound; e.g., Bellingham Bay/Samish Bay, Skagit Bay/Saratoga Passage, Port Susan/Possession Sound, central and south Puget Sound, and Hood Canal. The selectivity of gillnet gear is directly related to the mesh size, which is commonly expressed as the stretched diagonal dimension. Fishing regulations specify the mesh dimension for each gillnet fishery; different mesh sizes are specified for each target species. Chinook-directed gillnet fisheries typically use 6½-inch mesh, which is ineffective in capturing the smallest and largest size classes of chinook salmon. Pink- and coho-directed salmon fisheries typically use smaller mesh (e.g., 5-inch), which captures fewer large chinook, and a larger number of smaller chinook salmon. Capture efficiency is also affected by many other factors, including ambient light, water clarity, net design (hanging), and current. ~~The size- or age-composition of chinook salmon before and after they encounter a net fishery has not been experimentally compared in Puget Sound, so the vulnerability of different ages or sizes of chinook salmon has not been quantified.~~

Each year, Puget Sound fisheries during the ~~period 2004~~ 2005–2009 fishing seasons will harvest varying proportions of five cohorts of chinook salmon (i.e., Age-2, 3, 4, 5, and 6 fish). During that period, Puget Sound fisheries will affect the dominant age classes of five brood cycles (brood years 2001–2005). As discussed in Subsection 3.3.7, the majority of harvest will be of Age-3 to Age-5 fish, with Age-4 fish comprising the largest proportion. The primary concern is that Puget Sound fisheries might remove a large proportion of older, larger chinook salmon, or chinook that, if not harvested, would be larger and older at maturity, and that depleted of these age and size classes, spawners that escape fisheries would be less productive. However, the magnitude of the immediate effect on the cohorts of a population that are vulnerable to fishing in a given year will depend on fishing pressure (exploitation rate) and how the fishing season is structured. Under Alternative 1, annual exploitation rates would range from 17 to 76 percent on Puget Sound chinook management units depending on the scenario; rates would be below 40 percent for 10 of the 15 management units (Table 4.3.6.1-1). Southern U.S. exploitation rates would range from 5 to 68 percent depending on the scenario and management unit; rates would be below 40 percent for twelve of the fifteen management units (Table 4.3.6.1-1). For most natural units, then, under Alternative 1, two-thirds of the management units would experience total exploitation rates below the level where selective effects might occur (Hard 2004). Only three management units (Green-Duwamish, Nisqually and Skokomish) would experience exploitation rates above this level directly as a result of southern U.S. fisheries (primarily in Puget Sound) (Table 4.3.6.1-2). Commercial fisheries would not operate continuously through the fishing season. In most fishing areas, commercial openings would be scheduled for one to three days per week. This *pulsed* schedule is designed to distribute harvest mortality and escapement across the entire migration timing of the population(s) present in that area. Recreational fisheries would generally open for longer periods, though effort is expected to be much higher on weekends and holidays. Recreational fisheries that target immature chinook salmon in the winter and spring (November through April) would be open for intermittent month-long periods (i.e., they would not operate continuously for 6 months).

If the Alternative 1 fisheries regime were implemented for the ~~2004~~ 2005–2009 ~~management years~~fishing seasons, it would be expected to exert minor changes to the age and size composition of most Puget Sound chinook salmon populations that, absent fishing, would spawn naturally. Each year, the fishery will influence the age and size composition of spawners in that year, and in three or four subsequent years (i.e., when the youngest cohort contributing to that year's fishery matures). As a result, fisheries implemented under Alternative 1 during the ~~2004~~ 2005–2009 fishing seasons would affect the dominant age classes of five brood cycles (brood years ~~2001~~ 2002–2005). Similarly, the composition of spawners in ~~2004~~ 2005–~~2006~~2009 will have already been influenced by fisheries prior to ~~2004~~ 2005. If, as some studies assert, the productivity of a given population is, under adverse freshwater conditions, more dependent on the higher fecundity and spawning success (i.e., number of fertilized eggs per female) of older, larger fish, then the productivity of the period ~~2004~~ 2005–2009 broods might be lower as a result of fishing. Data are not available to estimate the magnitude of the short-term effect (i.e., the reduction in recruits per spawner for, say, the ~~2004~~ 2005 brood) for any of the affected broods, nor has it been estimated empirically for any previous brood year. Smolt production is strongly influenced by complex environmental factors, and is particularly sensitive to the magnitude of high flows during the incubation season (Seiler et al 2000). Though redds constructed by older or larger females may be somewhat less vulnerable to high flow, the reduction in productivity implied by a slightly lower proportion of older spawners cannot be estimated in the face of high uncertainty about flow conditions that will prevail in the winters of ~~2004~~ 2005–2010.

Further circumstantial evidence suggests that the long-term selective effects of fisheries are predicted to be minor, if not undetectable. The average fecundity of mature Skagit River summer chinook salmon has not declined from 1973 to the present (Orrell 1976; and SSC 2002). The age composition of Skagit River summer/fall chinook salmon harvested in the terminal area has varied widely over the last 30 years, particularly with respect to the proportions of Age-3 and Age-4 fish, but there is no declining trend in the contribution of Age-5 fish, which has averaged 15 percent (Henderson and Hayman 2002; and R. Hayman, Skagit Systems Cooperative December 9, 2002, personal communication).

As described in Subsection 3.3.7, no decline in average age has been detected for other Puget Sound chinook salmon populations for which data are available (Figure 3.3.7-2), including the Green-Duwaumish which commonly experienced fishery exploitation rates of 60 to 70 percent through the early 1990s. Collectively, the mixture of upward and downward observed trends in size-at-age for the Puget Sound chinook salmon populations analyzed, and the fact that the expected trends estimated by the harvest model generally explain only a modest fraction (<50%) of corresponding observed trends, suggest that environmental influences are large on the observed size trends. It was not possible from the present analysis to discriminate reliably between harvest and environmental effects on growth and size. Declining total exploitation rates on most natural chinook salmon stocks in Puget Sound in the last ten years (1991–2001) from averages of 70 to 90 percent to averages of 30 to 50 percent, due in part to decline in exploitation rates in Puget Sound fisheries, would suggest that selective pressure has also been reduced. Exploitation rates are expected to remain lower during implementation of the Proposed

Action. To the extent that effects have been detected, they would be expected to decrease under these lower rates unless the use of selective gear types increases.

In light of the information presented above, implementation of Alternative 1 is predicted to have a no to low negative effect on size and age as a result of the size-selective effects of fishing.

Table 4.3.6.1-1. Range of expected total exploitation rates by Puget Sound chinook management unit during the period ~~2004~~ 2005–2009.

Puget Sound Chinook	**Alternative 1**		**Alternative 2**		**Alternative 3**		**Alternative 4**	
(Management Unit/Population)	**minimum**	**maximum**	**minimum**	**maximum**	**minimum**	**maximum**	**minimum**	**maximum**
Dungeness Spring	0.22	0.29	0.19	0.26	0.19	0.26	0.19	0.26
Western Strait-Hoko	0.23	0.30	0.19	0.26	0.19	0.26	0.19	0.26
Elwha	0.22	0.30	0.19	0.26	0.19	0.26	0.19	0.26
Nooksack Spring	0.20	0.26	0.14	0.20	0.14	0.20	0.14	0.20
Skagit								
Spring	0.23	0.28	0.12	0.17	0.12	0.17	0.12	0.17
Upper Sauk								
Suiattle								
Upper Cascade								
Summer/Fall	0.48	0.56	0.32	0.43	0.32	0.43	0.32	0.43
Lower Sauk								
Upper Skagit								
Lower Skagit								
Stillaguamish	0.17	0.20	0.52	0.67	0.08	0.11	0.08	0.11
Snohomish	0.19	0.23	0.10	0.23	0.10	0.13	0.09	0.13
Lake Washington	0.31	0.38	0.18	0.25	0.18	0.25	0.18	0.25
Green-Duwamish	0.49	0.63	0.36	0.56	0.36	0.56	0.18	0.25
Puyallup	0.49	0.50	0.57	0.71	0.57	0.71	0.18	0.25
Nisqually	0.64	0.76	0.61	0.73	0.61	0.73	0.16	0.23
White Spring	0.20	0.20	0.22	0.46	0.22	0.46	0.02	0.03
Mid-Canal	0.26	0.34	0.19	0.28	0.19	0.28	0.19	0.28
Skokomish	0.45	0.63	0.43	0.61	0.43	0.61	0.19	0.28

Exploitation rates greater than 0.4 are shaded.

Table 4.3.6.1-2. Range of expected southern U.S. exploitation rates by Puget Sound chinook management unit during the period ~~2004~~ 2005–2009.

Puget Sound Chinook (Management Unit/Population)	**Alternative 1** minimum	**Alternative 1** maximum	**Alternative 2** minimum	**Alternative 2** maximum	**Alternative 3** minimum	**Alternative 3** maximum	**Alternative 4** minimum	**Alternative 4** maximum
Dungeness Spring	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Western Strait-Hoko	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Elwha	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Nooksack Spring	0.07	0.07	0.01	0.01	0.01	0.01	0.01	0.01
Skagit								
Spring	0.14	0.15	0.02	0.02	0.02	0.02	0.02	0.02
Upper Sauk								
Suiattle								
Upper Cascade								
Summer/Fall	0.16	0.18	0.00	0.01	0.00	0.01	0.00	0.01
Lower Sauk								
Upper Skagit								
Lower Skagit								
Stillaguamish	0.11	0.12	0.43	0.60	0.02	0.02	0.02	0.02
Snohomish	0.13	0.14	0.03	0.16	0.10	0.13	0.03	0.03
Lake Washington (Cedar River	0.20	0.23	0.05	0.05	0.05	0.05	0.05	0.05
Green-Duwamish	0.36	0.51	0.18	0.42	0.18	0.42	0.05	0.05
Puyallup	0.35	0.39	0.39	0.57	0.39	0.57	0.05	0.05
Nisqually	0.53	0.68	0.47	0.63	0.47	0.63	0.07	0.08
White Spring	0.17	0.19	0.20	0.46	0.20	0.46	0.01	0.01
Mid-Canal	0.12	0.13	0.05	0.05	0.05	0.05	0.05	0.05
Skokomish	0.26	0.50	0.23	0.46	0.23	0.46	0.05	0.05

Exploitation rates greater than 0.4 are shaded.

4.3.6.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Implementation of Alternative 3 for the ~~2004~~ 2005–2009 ~~management years~~fishing seasons would preclude marine net and recreational fisheries in Puget Sound except for a small marine net fishery in Tulalip Bay, and substantially reduce exploitation rates on most chinook salmon natural management units. The size-selective effects of pre-terminal net fisheries predicted to occur under Alternative 1, would not occur. Except for the limited Tulalip Bay fishery, gillnet fishery effects would be confined to those associated with in-river fisheries, and further confined to fisheries directed at other species in most rivers. The selective effects of recreational fisheries, which with Alternative 1 would operate under a 22-inch minimum size restriction, would also be eliminated.

The consequences of implementing Alternative 2, however, cannot be quantified in terms of a change in the age- or size-composition of chinook spawners during the period 200~~4~~5–2009. Though exploitation rates would be lower for most populations relative to Alternative 1, these would be declines from already-low rates for most populations in the ESU. In addition, although overall, rates would be lower than under Alternative 1, exploitation rates would generally be greater than 40 percent for many of the same management units noted under Alternative 1. The range of exploitation rates for two additional management units (White River [upper end of range only] and Stillaguamish) are anticipated to exceed 40 percent, significantly greater than the rates anticipated under Alternative 1. Seven management units could exceed 40 percent exploitation rate as compared with five management units under Alternative 1, although the lower end of the range for the Skagit summer/fall and Green-Duwamish management units would be below 40 percent under Alternative 2 (Table 4.3.6.1-1). Six management units would be expected to exceed 40 percent exploitation in southern U.S. fisheries compared with three under Alternative 1 (Table 4.3.6.1-2). However, where exploitation rates would be lower than under Alternative 1, it is reasonable to expect that the proportion of older and larger fish in the escapement in many rivers would increase slightly; i.e., decreasing selective effects. On the other hand, the shift to terminal-area fishing could increase the use of selective gear types; i.e., gillnets and hook-and-line recreational gear, and the greater number of management units anticipated to exceed 40 percent exploitation could mean an increase in selective effects compared with Alternative 1. For these reasons, there is too much uncertainty to predict the effects of implementing Alternative 2 on selective fishing effects.

4.3.6.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Implementation of Alternative 3 for the ~~2004~~ 2005–2009 management years would preclude marine net and recreational fisheries in Puget Sound, and substantially reduce exploitation rates on most chinook salmon natural populations. The size-selective effects of pre-terminal net fisheries predicted to occur under Alternative 1, would not be occur under Alternative 3. Gillnet fishery effects would be confined to those associated with in-river fisheries, and further confined to fisheries directed at other species in most rivers. The selective effects of marine recreational fisheries, which with Alternative 1 would operate under a 22-inch minimum size restriction, would also be eliminated.

Since, except for the Tulalip Bay and Stillaguamish fisheries in Alternative 2, the fisheries under Alternative 3 would be identical to those under Alternative 2, it is also anticipated that the selective fishing effects would be similar. Under Alternative 3, 6 management units out of 15 would be anticipated to exceed 40 percent exploitation rate, as compared with five under Alternative 1 and seven under Alternative 2. Five management units would be anticipated to exceed 40 percent exploitation rate in southern U.S. fisheries as compared with three under Alternative 1 and six under Alternative 2. For the reasons described under Alternative 2, there is too much uncertainty to predict the effects of implementing Alternative 3 on selective fishing effects.

4.3.6.4 Alternative 4 – No Action/No Authorized Take

The closing of all fisheries that involve any take of listed Puget Sound chinook salmon would substantially lower exploitation rates on all populations relative to Alternative 1, and would eliminate any size- and age-selective effects associated with Puget Sound gillnet and recreational fisheries. The short-term consequences would include a substantial increase in escapement to all chinook salmon-producing rivers, and there would likely be some increase in proportions of ages and size represented in the spawning population. Given that observed size-selective effects of fisheries ~~have not been observed in~~ are modest, at best, for some Puget Sound chinook salmon populations, and decreases in exploitation rates would, in most cases, be from levels that are anticipated to cause low levels of size-selective effects at most, implementation of Alternative 3 is predicted to have no to low beneficial effects compared to Alternative 1.

4.3.7 Hatchery-Related Fishery Effects On Salmon: Straying and Overfishing

As discussed in Subsection 3.3.7 of this Environmental Impact Statement, there are two hatchery-related effects to natural-origin salmon associated with fishing. The first is straying of hatchery-origin fish that are not caught, onto the spawning grounds where they may interact with natural populations potentially leading to a decrease in overall natural population productivity. Since not all hatchery fish return to the hatchery, any increases in hatchery returns could be expected to increase the probability for higher numbers of hatchery fish spawning in the wild. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition and genetic diversity effects in some areas. The second hatchery-related effect is the potential to overfish natural populations while pursuing harvestable hatchery-origin fish. One of the purposes of the Proposed Action is to create opportunities to harvest commingled populations, including hatchery-raised chinook, while providing an adequate level of protection to natural chinook salmon populations. In attempting to maximize harvest of hatchery fish, the commingled natural fish could be overharvested; i.e., harvested at a rate that is not sustainable based on the underlying productivity of the natural population. The potential effects on Puget Sound chinook salmon populations from overfishing are discussed in Section 4.3.1, which quantifies the impacts of the Proposed Action and alternatives in terms of exploitation rate and escapement of natural Puget Sound chinook populations. These effects will not be discussed further here.

Estimated escapement patterns for chinook salmon under the Proposed Action or alternatives for purposes of evaluating the two potential hatchery-related effects on natural-origin salmon are presented in Tables 4.3.7-1 through 4.3.7-5 by scenario. Potential contribution of hatchery-origin chinook salmon adults to the naturally-spawning population is presented in Table 4.3.7-7. Estimated escapement patterns for coho and chum are presented in Tables 4.3.7-8 and 4.3.7-9. The model runs on which these numbers are based are found in Appendix B. These are the Puget Sound salmon species with the largest hatchery production, and therefore the species with the greatest potential for hatchery-related effects. Puget Sound hatchery production of pink and sockeye salmon is relatively small by comparison. Results for chinook salmon are presented by alternative and scenario, with the discussion of comparison among alternatives focused on Scenario B, since that is the most likely to occur during implementation of the Proposed Action (see Subsection 4.2, Basis for Comparison of Alternatives and Approach to Alternatives Analysis, for background discussion.)

4.3.7.1 Straying of Hatchery Chinook

Under the alternatives analyzed, hatchery escapement would vary in concert with natural escapement. Alternative 4 (No Authorized Take/Status Quo) is predicted to result in the highest escapement levels, for both hatchery- and naturally-spawning chinook, regardless of scenario. In most cases, Alternative 1 is predicted to result in the lowest overall hatchery escapement levels, and the lowest natural escapement for the Strait of Juan de Fuca, North Puget Sound, and Hood Canal populations (Table 4.3.7-1). Total natural chinook escapement is predicted to show no to low changes (-6% to +3%) under Alternatives 2 or 3 compared with Alternative 1, and low to moderate changes in total hatchery escapement, with the direction of change depending on the scenario. Compared with Alternative 1, Alternative 4 is predicted to result in substantial increases in total natural escapement of chinook salmon when abundance is similar to that in 2003 (Scenarios A or B), and moderate increases in escapement when abundance is low (Scenarios C or D). Hatchery escapements under Alternative 4 are predicted to substantially increase under all scenarios (62 to 89%) (Table 4.3.7-1).

Table 4.3.7-1. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives by scenario.

CHINOOK	Scenario A						Scenario B					
	Comparisons to the Proposed Action						Comparisons to the Proposed Action					
	Natural Escapment			Hatchery Escapement			Natural Escapment			Hatchery Escapement		
	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca												
Dungeness Spring	2%	2%	2%				2%	2%	2%			
Western Strait-Hoko	3%	3%	3%				3%	3%	3%			
Elwha	2%	2%	2%				2%	2%	2%			
Regional Average	2%	2%	2%				3%	3%	3%			
North Sound												
Nooksack Spring	9%	9%	9%				13%	13%	13%			
Nooksack/Samish summer-fall				237%	237%	0%				1%	1%	1%
Skagit												
Spring	8%	8%	8%	8%	8%	8%	9%	9%	9%	9%	9%	9%
Summer/Fall	26%	26%	26%				26%	26%	26%			
Stillaguamish	-61%	6%	6%				-60%	7%	7%			
Snohomish	-9%	8%	9%	-12%	8%	19%	-6%	10%	10%	-9%	20%	20%
Tulalip Tribal Hatchery				99%	7974%	7974%				101%	7990%	7990%
Regional Average	-5%	11%	12%	78%	85%	9%	-4%	13%	13%	0%	10%	10%
South Sound												
Lake Washington (Cedar River)	1%	1%	1%	18%	18%	18%	0%	0%	0%	19%	19%	19%
Green-Duwamish	0%	0%	81%	19%	19%	116%	0%	0%	75%	19%	19%	109%
Puyallup	-50%	-50%	37%	-53%	-53%	99%	-50%	-50%	31%	-54%	-54%	86%
Nisqually	-1%	-1%	202%	0%	0%	204%	-2%	-2%	190%	-2%	-2%	191%
White Spring	-32%	-32%	25%				-31%	-31%	23%			
Gorst, Grovers, Minter, Chambers				31%	31%	42%				29%	29%	40%
& McAllister, Deschutes												
Regional Average	-16%	-16%	69%	3%	3%	96%	-17%	-17%	64%	2%	2%	89%
Hood Canal												
Mid-Canal	4%	4%	4%				5%	5%	5%			
Skokomish	1%	1%	105%	1%	1%	100%	0%	0%	92%	0%	0%	88%
Hoodsport H, Dewato, Union,	6%	6%	6%	-67%	-67%	237%	6%	6%	6%	-66%	-66%	235%
& Tahuya tribs.												
Regional Average	2%	2%	54%	26%	26%	77%	2%	2%	48%	26%	26%	77%
Average	-6%	0%	33%	17%	19%	89%	-5%	0%	31%	-9%	-6%	84%

CHINOOK	Scenario C						Scenario D					
	Comparisons to the Proposed Action						Comparisons to the Proposed Action					
	Natural Escapment			Hatchery Escapement			Natural Escapment			Hatchery Escapement		
	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca												
Dungeness Spring	2%	2%	2%				3%	3%	3%			
Western Strait-Hoko	3%	3%	3%				4%	4%	4%			
Elwha	2%	2%	2%				3%	3%	3%			
Regional Average	3%	3%	3%				3%	3%	3%			
North Sound												
Nooksack Spring	9%	9%	9%				13%	13%	13%			
Nooksack/Samish summer-fall				0%	0%	0%				121%	121%	1%
Skagit												
Spring	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Summer/Fall	27%	27%	27%				27%	27%	27%			
Stillaguamish	-44%	7%	7%				-42%	7%	7%			
Snohomish	9%	9%	9%	20%	20%	20%	9%	9%	9%	20%	20%	20%
Tulalip Tribal Hatchery				9517%	9517%	9517%				9484%	9484%	9484%
Regional Average	2%	13%	13%	10%	10%	10%	4%	13%	13%	50%	50%	10%
South Sound												
Lake Washington (Cedar River)	-4%	-4%	-4%	0%	0%	0%	-5%	-5%	-5%	24%	24%	24%
Green-Duwamish	0%	0%	27%	31%	31%	66%	0%	0%	21%	33%	33%	61%
Puyallup	-33%	-33%	28%	-26%	-26%	120%	-35%	-35%	19%	-30%	-30%	96%
Nisqually	-2%	-2%	108%	-1%	-1%	109%	-1%	-1%	104%	0%	0%	105%
White Spring	-1%	-1%	27%				-1%	-1%	23%			
Gorst, Grovers, Minter, Chambers				44%	44%	55%				46%	46%	57%
& McAllister, Deschutes												
Regional Average	-8%	-8%	37%	9%	9%	70%	-8%	-8%	32%	15%	15%	69%
Hood Canal												
Mid-Canal	5%	5%	5%				5%	5%	5%			
Skokomish	-1%	-1%	40%	-1%	-1%	38%	-1%	-1%	32%	-1%	-1%	32%
Hoodsport H, Dewato, Union,	6%	6%	6%	-56%	-56%	212%	6%	6%	6%	-54%	-54%	207%
& Tahuya tribs.												
Regional Average	2%	2%	22%	26%	26%	77%	2%	2%	19%	26%	26%	77%
Average	-1%	3%	19%	-3%	-3%	64%	0%	3%	18%	14%	14%	62%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-2. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario A.

CHINOOK	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action: Natural Escapement			Comparisons to the Proposed Action: Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca														
Dungeness Spring	--	352	--	360	--	360	--	360	2%	2%	2%			
Western Strait-Hoko	--	785	--	807	--	807	--	807	3%	3%	3%			
Elwha	--	2,125	--	2,172	--	2,172	--	2,172	2%	2%	2%			
Regional Average									2%	2%	2%			
North Sound														
Nooksack Spring	--	388	--	422	--	422	--	422	9%	9%	9%			
Nooksack/Samish summer-fall	10,044	--	33,887	--	33,887	--	10,083	--				237%	237%	0%
Skagit														
Spring	1,136	1,921	1,229	2,073	1,230	2,074	1,230	2,074	8%	8%	8%	8%	8%	8%
Summer/Fall	118	11,633	147	14,656	147	14,656	147	14,656	26%	26%	26%			
Stillaguamish	--	2,322	--	903	--	2,468	--	2,468	-61%	6%	6%			
Snohomish	4,564	5,073	4,024	4,634	4,933	5,475	5,432	5,504	-9%	8%	9%	-12%	8%	19%
Tulalip Tribal Hatchery	98	--	195	--	7,906	--	7,906	--				99%	7974%	7974%
Regional Average									-5%	11%	12%	78%	85%	9%
South Sound														
Lake Washington (w Cedar River index)	4,632	305	5,448	307	5,449	307	5,449	307	1%	1%	1%	18%	18%	18%
Green-Duwamish	5,016	5,819	5,948	5,800	5,948	5,800	10,827	10,558	0%	0%	81%	19%	19%	116%
Puyallup	2,338	2,392	1,100	1,200	1,100	1,200	4,656	3,286	-50%	-50%	37%	-53%	-53%	99%
Nisqually	4,911	1,106	4,913	1,100	4,913	1,100	14,908	3,338	-1%	-1%	202%	0%	0%	204%
White Spring	--	1,468	--	1,000	--	1,000	--	1,831	-32%	-32%	25%			
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes	29,528	--	38,545	--	38,547	--	41,786	--				31%	31%	42%
Regional Average									-16%	-16%	69%	3%	3%	96%
Hood Canal														
Mid-Canal	--	531	--	552	--	552	--	552	4%	4%	4%			
Skokomish	6,104	1,211	6,174	1,218	6,175	1,218	12,214	2,482	1%	1%	105%	1%	1%	100%
Hoodsport H, Dewato, Union, Tahuya tribs	5,594	591	1,851	625	1,851	625	18,833	625	6%	6%	6%	-67%	-67%	237%
Regional Average									2%	2%	54%	26%	26%	77%
Total	109,447	42,438			138,057	37,627	195,999	55,708	Ave -6%	0%	22%	17%	19%	89%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-3. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario B.

CHINOOK	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action: Natural Escapement			Comparisons to the Proposed Action: Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca														
Dungeness Spring	--	336	--	344	--	344	--	344	2%	2%	2%			
Western Strait-Hoko	--	750	--	772	--	772	--	772	3%	3%	3%			
Elwha	--	2,031	--	2,079	--	2,079	--	2,079	2%	2%	2%			
Regional Average									3%	3%	3%			
North Sound														
Nooksack Spring	--	365	--	412	--	412	--	412	13%	13%	13%			
Nooksack/Samish summer-fall	9,855	--	9,906	--	9,906	--	9,906	--				1%	1%	1%
Skagit														
Spring	1,088	1,845	1,188	2,009	1,189	2,010	1,189	2,010	9%	9%	9%	9%	9%	9%
Summer/Fall	110	11,029	139	13,935	139	13,935	139	13,935	26%	26%	26%			
Stillaguamish	--	2,281	--	904	--	2,446	--	2,446	-60%	7%	7%			
Snohomish	4,342	4,901	3,947	4,603	5,203	5,368	5,203	5,368	-6%	10%	10%	-9%	20%	20%
Tulalip Tribal Hatchery	96	--	192	--	7,730	--	7,730	--				101%	7990%	7990%
Regional Average									-4%	13%	13%	0%	10%	10%
South Sound														
Lake Washington (w Cedar River index)	4,449	294	5,273	295	5,274	295	5,274	295	0%	0%	0%	19%	19%	19%
Green-Duwamish	5,019	5,816	5,982	5,800	5,981	5,800	10,470	10,153	0%	0%	75%	19%	19%	109%
Puyallup	2,424	2,419	1,109	1,200	1,109	1,200	4,506	3,160	-50%	-50%	31%	-54%	-54%	86%
Nisqually	5,007	1,126	4,920	1,100	4,920	1,100	14,587	3,261	-2%	-2%	190%	-2%	-2%	191%
White Spring	--	1,459	--	1,000	--	1,000	--	1,792	-31%	-31%	23%			
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes	28,954	--	37,477	--	37,479	--	40,641	--				29%	29%	40%
Regional Average									-17%	-17%	64%	2%	2%	89%
Hood Canal														
Mid-Canal	--	504	--	527	--	527	--	527	5%	5%	5%			
Skokomish	6,213	1,237	6,220	1,231	6,221	1,231	11,662	2,370	0%	0%	92%	0%	0%	88%
Hoodsport H, Dewato, Union, Tahuya tribs	5,372	562	1,850	597	1,850	597	17,983	597	6%	6%	6%	-66%	-66%	235%
Regional Average									2%	2%	48%	26%	26%	77%
Total	109,447	42,438			138,057	37,627	195,999	55,708	Aver -5%	0%	22%	-9%	-6%	84%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.
Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-4. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario C.

CHINOOK	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action: Natural Escapement			Comparisons to the Proposed Action: Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca														
Dungeness Spring	--	245	--	251	--	251	--	251	2%	2%	2%			
Western Strait-Hoko	--	545	--	564	--	564	--	564	3%	3%	3%			
Elwha	--	1,480	--	1,516	--	1,516	--	1,516	2%	2%	2%			
Regional Average									3%	3%	3%			
North Sound														
Nooksack Spring	--	278	--	304	--	304	--	304	9%	9%	9%			
Nooksack/Samish summer-fall	9,528	--	9,571	--	9,571	--	9,571	--				0%	0%	0%
Skagit														
Spring	788	1,331	865	1,460	865	1,460	865	1,460	10%	10%	10%	10%	10%	10%
Summer/Fall	80	8,033	102	10,215	102	10,215	102	10,215	27%	27%	27%			
Stillaguamish	--	1,620	--	909	--	1,738	--	1,738	-44%	7%	7%			
Snohomish	3,185	3,543	3,812	3,875	3,812	3,875	3,812	3,875	9%	9%	9%	20%	20%	20%
Tulalip Tribal Hatchery	58	--	5,531	--	5,531	--	5,531	--				9517%	9517%	9517%
Regional Average									2%	13%	13%	10%	10%	10%
South Sound														
Lake Washington (w Cedar River index)	3,082	223	3,084	214	3,084	214	3,084	214	-4%	-4%	-4%	0%	0%	0%
Green-Duwamish	4,558	5,801	5,950	5,800	5,950	5,800	7,558	7,367	0%	0%	27%	31%	31%	66%
Puyallup	1,478	1,798	1,100	1,200	1,100	1,200	3,250	2,293	-33%	-33%	28%	-26%	-26%	120%
Nisqually	4,972	1,119	4,914	1,100	4,914	1,100	10,408	2,330	-2%	-2%	108%	-1%	-1%	109%
White Spring	--	1,011	--	1,000	--	1,000	--	1,283	-1%	-1%	27%			
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes	18,808	--	27,007	--	27,007	--	29,169	--				44%	44%	55%
Regional Average									-8%	-8%	37%	9%	9%	70%
Hood Canal														
Mid-Canal	--	367	--	385	--	385	--	385	5%	5%	5%			
Skokomish	6,147	1,239	6,080	1,221	6,080	1,221	8,513	1,730	-1%	-1%	40%	-1%	-1%	38%
Hoodsport H, Dewato, Union, Tahuya tribs	4,209	410	1,857	436	1,857	436	13,126	436	6%	6%	6%	-56%	-56%	212%
Regional Average									2%	2%	22%	26%	26%	77%
Total	109,447	42,438			138,057	37,627	195,999	55,708	Ave -1%	3%	22%	-3%	-3%	64%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.
Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Table 4.3.7-5. Comparisons of hatchery- and naturally-spawning chinook salmon escapement with the Proposed Action or alternatives under Scenario D.

CHINOOK	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action: Natural Escapement			Comparisons to the Proposed Action: Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca														
Dungeness Spring	--	231	--	237	--	237	--	237	3%	3%	3%			
Western Strait-Hoko	--	514	--	532	--	532	--	532	4%	4%	4%			
Elwha	--	1,395	--	1,431	--	1,431	--	1,431	3%	3%	3%			
Regional Average									3%	3%	3%			
North Sound														
Nooksack Spring	--	252	--	285	--	285	--	285	13%	13%	13%			
Nooksack/Samish summer-fall	9,370	--	20,673	--	20,673	--	9,424	--				121%	121%	1%
Skagit														
Spring	749	1,270	825	1,395	825	1,395	825	1,395	10%	10%	10%	10%	10%	10%
Summer/Fall	75	7,551	96	9,625	96	9,625	96	9,625	27%	27%	27%			
Stillaguamish	--	1,584	--	919	--	1,702	--	1,702	-42%	7%	7%			
Snohomish	3,007	3,399	3,596	3,720	3,596	3,720	3,600	3,720	9%	9%	9%	20%	20%	20%
Tulalip Tribal Hatchery	56	--	5,351	--	5,351	--	5,351	--				9484%	9484%	9484%
Regional Average									4%	13%	13%	50%	50%	10%
South Sound														
Lake Washington (w Cedar River index)	2,933	214	3,648	204	3,648	204	3,648	204	-5%	-5%	-5%	24%	24%	24%
Green-Duwamish	4,512	5,802	5,995	5,800	5,995	5,800	7,242	7,006	0%	0%	21%	33%	33%	61%
Puyallup	1,588	1,834	1,113	1,200	1,113	1,200	3,118	2,180	-35%	-35%	19%	-30%	-30%	96%
Nisqually	4,935	1,109	4,920	1,100	4,920	1,100	10,124	2,264	-1%	-1%	104%	0%	0%	105%
White Spring	--	1,011	--	1,000	--	1,000	--	1,246	-1%	-1%	23%			
Gorst, Grovers, Minter, Chambers & McAllister, Deschutes	17,893	--	26,063	--	26,063	--	28,157	--				46%	46%	57%
Regional Average									-8%	-8%	32%	15%	15%	69%
Hood Canal														
Mid-Canal	--	344	--	361	--	361	--	361	5%	5%	5%			
Skokomish	6,069	1,225	6,038	1,215	6,038	1,215	7,983	1,622	-1%	-1%	32%	-1%	-1%	32%
Hoodsport H, Dewato, Union, Tahuya tribs	4,010	384	1,854	408	1,854	408	12,309	408	6%	6%	6%	-54%	-54%	207%
Regional Average									2%	2%	19%	26%	26%	77%
Total	109,447	42,438			138,057	37,627	195,999	55,708	Ave 0%	3%	22%	14%	14%	62%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

Relatively small numbers of juvenile hatchery chinook are released each year into the watersheds where the Nooksack spring, Skagit, Stillaguamish, White, Dungeness and Elwha chinook salmon populations spawn and rear, either as indicator stocks for research (e.g., the Skagit hatchery programs), or as supplementation to aid in the recovery of the naturally-spawning chinook salmon populations. With the exception of the Elwha River, releases do not exceed one million juveniles each year. The hatchery programs in these systems all use the native chinook salmon populations as broodstock. Juvenile and adult hatchery fish from all but the Skagit programs are deemed essential for the recovery of the Puget Sound Chinook ESU, and are therefore listed. Straying of Skagit hatchery-origin spawning adults to natural spawning areas is insignificant because the numbers of adult fish produced by the low numbers of juveniles released is not substantial. For the other hatchery programs, escapement of adult fish produced through the supplementation programs that return to natural spawning areas is a primary objective of the program, and therefore generally seen as having an overall beneficial effect.

Annual hatchery releases of more than one million juvenile chinook salmon occur in the Snohomish, Lake Washington, Green-Duwamish, Puyallup, Nisqually and Skokomish watersheds. The hatchery programs located in the Snohomish and Green-Duwamish watersheds propagate chinook salmon derived from the native stock. Hatcheries in the Sammamish, Puyallup, Nisqually and Skokomish watersheds operate where native populations are no longer believed to exist. The hatchery and wild adult chinook salmon populations returning to these watersheds are indistinguishable from each other. With the exception of the Snohomish watershed, the majority of the returning adults are believed to be predominately first-generation, hatchery-origin fish, and any natural production is generally managed for composite escapements of hatchery- and wild-origin fish. Hatchery programs in these areas have been in place for 40 to 100 years. Given the stock origin of propagated fish, or the lack of native chinook salmon populations in these watersheds, continued straying of hatchery-origin spawning adults to natural spawning areas at present levels in these systems is unlikely to have a significant adverse effect on the extant natural-origin chinook salmon populations.

However, to the extent that increases in the contribution of hatchery-origin adults on the natural spawning grounds increase risks such as predation on naturally-produced salmon, or competition with naturally-produced salmon for food, and rearing and spawning areas, a reduction in the contribution of hatchery-origin adults on the natural spawning grounds would be considered a beneficial effect. Information is not currently available to determine with certainty what levels of hatchery contribution to naturally-spawning chinook populations in Puget Sound result in what levels of risk or benefit. State, tribal and federal agencies are currently engaged in on-going cooperative efforts to develop this understanding. Therefore, for the purpose of this analysis, a reduction in hatchery contribution will be considered a benefit, and the impact analysis metrics described in Subsection 4.3, Fish, will be used to describe the magnitude of change. All programs used in the analysis of the Proposed Action and alternatives would have significant hatchery contribution rates to natural spawning grounds regardless of the alternative or scenario (Table 4.3.7-9).

Under the alternative fishing regimes analyzed, the same factors that would cause natural escapements to increase (or decrease) would also result in higher (or lower) hatchery escapements. Since not all hatchery fish return to the hatchery, any increases in hatchery returns could be expected to increase the probability for higher numbers of hatchery fish spawning in the wild. Table 4.3.7-6 provides examples of stray rates for several key chinook salmon populations, where stray rate is defined as the proportion of the total hatchery-origin escapement not removed from the natural environment through trapping, or the number of hatchery-origin salmon that otherwise strayed from their point of release. The predicted contribution of hatchery fish to natural escapement is then computed by calculating the number of hatchery fish that would not return to the hatchery using the proportions in Table 4.3.7-6, and dividing that number by the natural escapement.

Table 4.3.7-6. Estimated 1996–2002 average number of hatchery-origin chinook salmon that spawn in the wild as a proportion of the hatchery-origin escapement for key Puget Sound chinook hatchery salmon populations under consideration (hatchery fish spawning in the wild/total hatchery fish returning).

Population	Average Hatchery Stray Rate (1996-2002)
Nooksack	
North Fork	.35
South Fork	.05
Snohomish	
Skykomish	.32
Snoqualmie	.09
Green-Duwamish	.40

Source: Puget Sound Technical Recovery Team Abundance and Productivity Tables (2003).

Stray rates are not yet available for other systems, pending evaluation of mass-marked hatchery-origin returns in future years. When that information is available, it will be used to assess the contribution of hatchery-origin fish to natural escapement. The results of that assessment are expected to indicate that hatchery fish stray rates for South Puget Sound and Hood Canal watersheds will be similar to or exceed that of the Green River, with proportionally greater risks of potential impacts to any natural-origin chinook salmon populations. Therefore, the populations in Table 4.3.7-6 will be used as examples to indicate the relative impact of the Proposed Action or alternatives.

Alternative 1 – Proposed Action/Status Quo

No change from current baseline conditions would result from implementation of Alternative 1.

Modeled scenarios for Alternative 1 showed little variation and no consistent pattern of hatchery contribution rates across the three representative systems (Nooksack spring, Snohomish and Green-Duwamish) (Table 4.3.7-7). For the Nooksack spring system, the modeled stray rate is predicted to be the same across modeled scenarios. For the Snohomish system, the modeled stray rate is predicted to be lowest under Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), followed by Scenario B (high abundance and maximum Canadian/Alaskan fisheries). Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003), and Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003) are predicted to have the same and the lowest hatchery contribution rate, respectively. The Green-Duwamish River system is predicted to have the lowest stray rate under Scenario D or Scenario C, followed by Scenario B or Scenario A.

Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 50 to 51 percent of total natural escapement in the Snohomish River system; and 52 to 58 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Hatchery contribution rates of out-of-watershed-origin chinook salmon at these levels indicate a substantial potential risk of adverse ecological and genetic effects to the indigenous natural-origin populations through competition and genetic introgression, respectively. However, hatchery-origin fish straying within these watersheds are predominately of native-population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. In addition, Nooksack hatchery chinook salmon are considered essential to the recovery of the ESU, and are therefore listed along with the natural-origin fish. Given these circumstances, straying hatchery fish are expected to result in a low to moderate short-term risk of adverse impact to the ability of natural populations to sustain themselves. Impacts over the long-term would also be expected to be low to moderate, since Alternative 1 is the baseline condition.

Table 4.3.7-7. Hatchery contribution to natural spawning escapement by scenario and alternative for five representative Puget Sound chinook populations.

CHINOOK		Scenario A				Scenario B				Scenario C				Scenario D			
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4
Nooksack Spring	Escapement to the hatchery	9,150	9,952	9,150	9,952	7,924	8,112	8,112	8,112	5,778	5,919	5,919	5,919	5,448	5,589	5,589	5,589
North Fork Nooksack	strays from hatchery to grounds	3,203	3,483	3,203	3,483	2,773	2,839	2,839	2,839	2,022	2,072	2,072	2,072	1,907	1,956	1,956	1,956
	% of hatchery return to hatchery	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
	total strays on grounds	4,927	5,359	4,927	5,359	4,267	4,368	4,368	4,368	3,111	3,187	3,187	3,187	2,933	3,009	3,009	3,009
South Fork Nooksack	strays from hatchery to grounds	458	498	458	498	396	406	406	406	289	296	296	296	272	279	279	279
	% of hatchery return to hatchery	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	total strays on grounds	482	524	482	524	417	427	427	427	304	312	312	312	287	294	294	294
Snohomish	Escapement to the hatchery	4,564	4,024	4,933	5,432	4,342	3,947	5,203	5,203	3,185	3,812	3,812	3,812	3,007	3,596	3,596	3,600
Skykomish	strays from hatchery to grounds	1,461	1,288	1,579	1,738	1,389	1,263	1,665	1,665	1,019	1,220	1,220	1,220	962	1,151	1,151	1,152
	% of hatchery return to hatchery	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
	total strays on grounds	2,148	1,894	2,322	2,556	2,043	1,857	2,449	2,449	1,499	1,794	1,794	1,794	1,415	1,692	1,692	1,694
Snoqualmie																	
	strays from hatchery to grounds	411	362	444	489	391	355	468	468	287	343	343	343	271	324	324	324
	% of hatchery return to hatchery	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
	total strays on grounds	451	398	488	537	429	390	515	515	315	377	377	377	297	356	356	356
Green-Duwamish	Escapement to the hatchery	5,016	5,948	5,948	10,827	5,019	5,982	5,981	10,470	4,558	5,950	5,950	7,558	4,512	5,995	5,995	7,242
	strays from hatchery to grounds	2,007	2,379	2,379	4,331	2,007	2,393	2,393	4,188	1,823	2,380	2,380	3,023	1,805	2,398	2,398	2,897
	% of hatchery return to hatchery	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	total strays on grounds	3,344	3,965	3,965	7,218	3,346	3,988	3,988	6,980	3,039	3,967	3,967	5,039	3,008	3,997	3,997	4,828

CHINOOK	Hatchery Contribution to Natural Spawning				Hatchery Contribution to Natural Spawning				Hatchery Contribution to Natural Spawning				Hatchery Contribution to Natural Spawning			
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4	Alt 1	Alt 2	Alt 3	Alt 4
Nooksack Spring	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%
Snohomish	51%	49%	51%	56%	50%	49%	55%	55%	51%	56%	56%	56%	50%	55%	55%	55%
Green-Duwamish	57%	68%	68%	68%	58%	69%	69%	69%	52%	68%	68%	68%	52%	69%	69%	69%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, November 2004.

Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system and increase within the Green-Duwamish River system, compared to Alternative 1. The hatchery contribution rate for the Snohomish River system is predicted to decline slightly under high abundance conditions (similar to those in 2003), and increase under low abundance conditions compared with Alternative 1. The magnitude of stray rates under Alternative 2 would be similar to those under Alternative 1.

Summary of Scenario Differences

As with Alternative 1, no consistent pattern of hatchery contribution rates was indicated across modeled scenarios among the three representative systems under Alternative 2 (Table 4.3.7-7). For the Nooksack spring system, the stray rate is predicted to be consistent across scenarios. For the Snohomish system, the modeled stray rate was lowest under Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003), and Scenario B (high abundance and maximum Canadian/Alaskan fisheries), followed by Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), and Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003). For the Green-Duwamish River system, the modeled stray rate was lowest under Scenarios A and C which had the same predicted stray rate, followed by Scenario B and Scenario D.

As with Alternative 1, there is little predicted variation in hatchery contribution rates across scenarios under Alternative 1 (Table 4.3.7-7). Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 49 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 2 with Alternative 1 (Proposed Action/Status Quo)

Under Alternative 2, Scenario B, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system; increase by 11 percent for the Green-Duwamish River system, and decline by 1 percent for the Snohomish River system compared to Alternative 1 (Table 4.3.7-7). The magnitude of stray rates under Alternative 2 is predicted to be similar to those predicted under Alternative 1.

Under Alternative 2, Scenarios A, C, or D, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system and increase for the Green-Duwamish River system by 11 to 17 percent compared to Alternative 1. The hatchery contribution rate for the Snohomish River system is predicted to decrease by 1 percent under Scenario A (same as Scenario B), and increase by 5 percent under Scenarios C or D, compared with Alternative 1 (Table 4.3.7-7). The differences in hatchery contribution rate between Alternative 2 and Alternative 1 would be greater under low abundance conditions (Scenarios C or D) than under high abundance conditions (Scenarios A or B) for the Snohomish and Green-Duwamish River systems.

As described under Alternative 1, the population origin of straying hatchery fish, and on-going hatchery reform measures implemented to reduce risks to natural-origin chinook salmon, bear upon any assessment of risk posed by straying hatchery fish to natural-origin fish populations. The hatchery contribution rates estimated under Alternative 2 could be expected to have an elevated adverse affect on the genetic diversity, and potentially on the productivity of natural-origin chinook salmon populations, relative to Alternative 1 for the Snohomish and Green-Duwamish River systems; however, again, the hatchery-origin fish straying within these watersheds are predominantly of native population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. Scenario B, the most likely to occur over the duration of the Proposed Action (the 2005~~4~~–2009 fishing seasons), is predicted to result in a no to low change in the hatchery contribution rate for the Nooksack spring and Snohomish systems, and a moderate change in the Green-Duwamish system hatchery contribution rate compared to Alternative 1. The greater potential for adverse effects would come from substantial increases in the escapements of hatchery coho and chum salmon that would occur in these areas. The much greater escapement of hatchery coho and chum salmon (Tables 4.3.7-8 and 4.3.7-9) could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Therefore, primarily as a result of straying non-chinook salmon species, moderate to substantial short- and long-term risks are predicted under Alternative 2 for hatchery fish straying at the levels described above to contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Under Alternative 1, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system; increase for the Green-Duwamish River system, and have at most a low increase for the Snohomish River system compared to Alternative 1.

Summary of Scenario Differences

As with Alternative 1 or 2, modeled scenarios showed little variation in hatchery contribution rates among the three representative systems. The hatchery contribution rate is predicted to be consistent across scenarios for the Nooksack spring and Green-Duwamish River systems. For the Snohomish system, the modeled stray rate was lowest under Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003). Hatchery contribution rates under Scenarios B (high abundance and maximum Canadian/Alaskan fisheries), D (30% reduction in abundance with maximum Canadian/Alaskan fisheries), or C (30% reduction in abundance with Canadian/Alaskan fisheries similar to those in 2003) are predicted to be higher, but within 1 percent of each other.

Hatchery strays are predicted to average approximately 93 percent of total natural escapement in the Nooksack spring system; 51 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of the total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 3 with Alternative 1 (the Proposed Action/Status Quo)

Under Alternative 3, Scenario B, the hatchery contribution rate is predicted to remain the same for the Nooksack spring system, increase by 5 percent for the Green-Duwamish River system, and increase 11 percent for the Snohomish River system compared to Alternative 1 (Table 4.3.7-7). The magnitude of the hatchery contribution rates under Alternative 3 would be similar to the rates under Alternative 1 or 2.

With the exception of Scenario A for the Snohomish system, Alternative 3 Scenarios A, C, or D are predicted to result in hatchery contribution rates relative to Alternative 1 of within 1 percent of those described for Scenario B. Hatchery contribution rates under Alternative 3, Scenario A, for Snohomish chinook salmon are predicted to be the same as Alternative 1, or 5 percent lower than under Scenario B. Hatchery contribution rates are predicted to range from 55 to 56 percent under Scenarios C and D for the Snohomish River system, and 68 to 69 percent under all scenarios for the Green-Duwamish River system (Table 4.3.7-7).

As described above, the population origin of straying hatchery fish, and on-going hatchery reform measures being implemented to reduce risks to natural-origin chinook salmon, bear upon any assessment of risk posed by the straying hatchery fish to natural-origin fish populations. The hatchery contribution rates estimated under Alternative 3 could be expected to have an elevated adverse affect on the genetic diversity, and potentially on the productivity of the Green-Duwamish and Snohomish system natural-origin chinook salmon populations, relative to Alternative 1; however, again, the hatchery-origin fish straying within these watersheds are predominantly of native population-origin, which is expected to attenuate the potential for adverse ecological and genetic effects. Scenario B, the most likely to occur over the duration of the Proposed Action (the 2005~~4~~–2009 fishing seasons), is predicted to result in a no to low change in the hatchery contribution rate for the Nooksack spring and Snohomish systems, and a moderate change in the Green-Duwamish system contribution rate compared with Alternative 1. The greater potential for adverse effects would come from substantial increases in the escapements of hatchery coho and chum salmon. The much greater escapement of hatchery coho and chum salmon (Tables 4.3.7-8 and 4.3.7-9) could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Under Alternative 3, primarily as a result of straying of non-chinook species, there would be moderate to substantial short- and long-term risk that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

Alternative 4 – No Action/No Authorized Take

The estimated hatchery contribution rate comparisons under Alternative 4 would be very similar to those estimated under Alternative 3.

Summary of Scenario Differences

Under Alternative 4, hatchery contribution rates are predicted to differ by 1 percent or less across scenarios for each system (Table 4.3.7-7). Hatchery strays would average approximately 93 percent of total natural escapement in the Nooksack spring system; 55 to 56 percent of total natural escapement in the Snohomish River system; and 68 to 69 percent of total natural spawners in the Green-Duwamish River system (Puget Sound Technical Recovery Team 2003).

Comparison of Alternative 4 with Alternative 1 (the Proposed Action/Status Quo)

The estimated hatchery contribution rates under Alternative 4, Scenario B, would be the same as those estimated under Alternative 3. The results of Scenarios A, C, or D are also predicted to be the same as Alternative 3, except for Scenario A for the Snohomish system (Table 4.3.7-7). The estimated contribution of hatchery-origin spawners to the Snohomish system natural escapement is predicted to increase to 56 percent, compared with 51 percent under Scenario A for Alternative 3 and Alternative 1. However, the magnitude of contribution rates is predicted to be the same as that of Alternative 3, so the level of hatchery-related effects to natural-origin chinook salmon populations associated with Alternative 4 would be unlikely to differ from effects surmised under Alternative 3. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Under Alternative 4, particularly because of the substantial increases in non-chinook hatchery escapements, there would be moderate to substantial short- and long-term risks that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves.

Summary

Hatchery contribution rates of chinook, coho, and chum salmon were predicted to be substantial for all alternatives. Chinook hatchery contribution rates were not predicted to change significantly with change in abundance or the magnitude of northern fisheries; varying 7 percent or less among scenarios for each alternative. The modeled differences in hatchery chinook contribution rates among alternatives were generally low, except for the Green-Duwamish River system where hatchery contribution rates are predicted to increased by as much as 17 percent under low abundance conditions when compared with Alternative 1. The much greater escapements of hatchery coho and chum salmon could exacerbate inter-species predation, competition, and genetic diversity effects in some areas. Particularly because of substantial increases in non-chinook hatchery escapements, there would likely be moderate to substantial short- and long-term risks that hatchery fish straying at the levels described above may contribute, combined with other factors for decline, to impairment of the ability of natural populations to sustain themselves under Alternatives 2, 3, or 4. Under Alternative 1, straying hatchery fish are expected to result in a low to moderate short-term risk of adverse impact to the ability of natural populations to sustain themselves. Impacts over the long-term are also expected to be low to moderate, since Alternative 1 is the baseline condition.

4.3.7.2 Straying of Coho and Chum Salmon

Both total hatchery and natural escapement for coho and chum salmon would show substantial increases (39% to 236%) in escapement under Alternatives 2, 3, or 4 compared with Alternative 1. For each alternative, the change in hatchery escapement is predicted to be 2 to 2.5 times the change in natural escapement (Tables 4.3.7-8 and 4.3.7-9). As with chinook salmon, changes in hatchery and natural escapements would vary by region and management unit. Stray rate estimates are not available for the coho and chum salmon management units in Tables 4.3.7-8 and 4.3.7-9.

Table 4.3.7-8. Comparisons of hatchery- and natural-spawning coho salmon escapement with the proposed action and alternatives. Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

COHO	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Alternative 3 - Escapement Goal/Pop Level/Terminal		Alternative 4 - No Listed Take		Comparisons to the Proposed Action						
										Natural Escapment			Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural		Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca															
Juan de Fuca	9,513	17,320	17,622	18,819	17,622	18,819	21,732	18,819		9%	9%	9%	1	85%	128%
Regional Average										9%	9%	9%	85%	85%	128%
North Sound															
Nooksack/Samish	27,508	8,182	56,057	14,272	56,057	14,272	56,057	15,305		74%	74%	87%	1	104%	104%
Skagit	5,840	73,624	9,241	109,887	9,241	109,887	9,253	110,022		49%	49%	49%	1	58%	58%
Stillaguamish	1,173	24,017	1,239	28,689	1,317	34,840	1,317	34,840		19%	45%	45%	0	12%	12%
Snohomish	13,494	136,873	17,854	165,820	30,938	187,066	30,938	187,066		21%	37%	37%	0	129%	129%
Regional Average										41%	51%	55%	50%	76%	76%
South Sound															
South Sound	119,369	47,086	233,962	69,945	233,962	69,945	293,781	97,804		49%	49%	108%	1	96%	146%
										49%	49%	108%	96%	96%	146%
Hood Canal															
Hood Canal	11,379	19,012	37,046	28,533	37,046	28,533	41,214	30,345		50%	50%	60%	2	226%	262%
Regional Average										44%	44%	64%	63%	63%	162%
Total	62,859	197,456			230,334	309,828	306,719	334,498	Aver	39%	45%	56%	87%	101%	120%

Table 4.3.7-9. Comparisons of hatchery- and natural-spawning chum salmon escapement with the proposed action and alternatives. Substantial differences (greater than 30%) in escapement from Alternative 1 are shaded.

CHUM	Alternative 1 - Proposed Action		Alternative 2 - Escapement Goal/Manag. Unit Level		Goal/Pop Level/Terminal Only		Alternative 4 - No Listed Take		Comparisons to the Proposed Action						
										Natural Escapment			Hatchery Escapement		
	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural		Alt2/Alt1	Alt3/Alt1	Alt4/Alt1	Alt2/Alt1	Alt3/Alt1	Alt4/Alt1
Juan de Fuca															
Juan de Fuca	--	2,585	--	2,722	--	2,722	--	2,722		5%	5%	5%			
Regional Average										5%	5%	5%			
North Sound															
Nooksack/Samish	7,936	35,610	17,713	79,482	17,713	79,482	17,717	79,501		123%	123%	123%	123%	123%	123%
Skagit	1,834	42,237	2,000	46,071	2,000	46,071	2,000	46,071		9%	9%	9%	9%	9%	9%
Stillaguamish	700	14,400	1,631	34,194	1,668	34,964	1,668	34,964		137%	143%	143%	133%	138%	138%
Snohomish	7,200	17,600	43,262	35,583	43,262	35,583	43,262	35,583		102%	102%	102%	501%	501%	501%
Regional Average										93%	94%	94%	192%	193%	193%
South Sound															
South Sound	17,540	150,923	46,459	399,761	46,459	399,761	51,310	441,499		165%	165%	193%	165%	165%	193%
Regional Average										165%	165%	193%	165%	165%	193%
Hood Canal															
Hood Canal	37,637	50,382	145,084	95,473	145,084	95,473	207,023	99,621		89%	89%	98%	285%	285%	450%
Regional Average										89%	89%	98%	285%	285%	450%
Total	72,846	313,736			256,149	693,285	322,981	739,961	Aver	90%	91%	96%	203%	204%	236%

Source: Larrie Lavoy, Puget Sound Chinook Resource Management Plan NEPA Interdisciplinary Team, March 2003 and November 2004.

4.3.8 Indirect and Cumulative Effects

4.3.8.1 Indirect Effects

Indirect effects on fish species are those that would be further removed from the direct effects. In the case of listed and unlisted salmonid species affected by the Proposed Action, the primary direct effect would be changes in spawning escapement brought about by changes in catch, and the primary indirect effect would be resulting changes in abundance of the progeny of these spawning populations. Because the action considered in this Environmental Impact Statement applies to a~~ six~~ five-year resource management plan, changes in abundance would be limited to the progeny of spawners returning from ~~2004~~ 2005 to 2010; i.e., progeny returning in~~ 2006~~ 2007–2015. The extent to which increased abundance of the progeny of these spawners may affect spawning abundance in subsequent years depends on freshwater and marine habitat conditions that influence survival, and on the fishing regimes that will be in place after 2010. Of these, marine conditions are thought to play the dominant short-term role.

In the case of chinook salmon, changes in spawning escapement would, theoretically, be most evident in the abundance of progeny returning as Age-3 and Age-4 spawners, though there would also be changes in abundance for Age-2 (precocious) spawners, and the relatively small proportion of chinook populations returning as Age-5 and Age-6 spawners. Similarly, for other species, changes in spawning escapement would apply to subsequent brood years according to the species age-at-maturity profiles. As noted in Subsection 4.3.1, these effects could be beneficial or negative, depending on the magnitude of change and the productivity characteristics of the particular watershed from which a population originates. An indirect effect that would likely result from fishery closures under Alternative 2 is the expected reduction in the amount of lost fishing gear in marine areas closed to fishing and, conversely, an increase in lost fishing gear in those terminal fisheries where fishing may increase. Changes in the number of lost or derelict nets affect the amount of unintended mortality on salmonids and other species that become entangled in lost nets and, to a lesser extent, lost sport fishing tackle. This issue is discussed in Subsection 3.3.5 (~~, ~~Fish Habitat Affected by Salmon Fishing): Affected Environment and Subsections 4.8.1 (Marine Birds) and 4.8.3 (Marine Invertebrates): Environmental Consequences.

A potential advantage to Alternative 1, which makes use of exploitation rate management strategies for many populations, is that, properly applied, exploitation rate management strategies are more robust about uncertainties in key parameters like survival and management error (Walters and Parma 1996) than fixed escapement goal strategies like those in Alternatives 2 and 3. ~~Given the imprecision of abundance forecasts, t~~This can be an important advantage, especially when combined with a strategy to use conservative parameters in forecasting (Fieberg ~~in press~~ 2004). Exploitation management strategies can also result in less variable harvests from year to year (Hilborn and Walters 1992; Walters and Parma 1996), an important factor for fishermen that rely on fishing for their family income. Also, in practical terms, true fixed escapement goal harvest management is difficult to impossible to implement. When direct and incidental harvest is regulated under several jurisdictions (national and international), it is not possible to actually reduce harvest exploitation rates to zero when threshold escapement levels cannot be achieved, although they can be significantly reduced.

Fieberg (2004) considered the uncertainty associated with estimating population productivity and with managing fisheries (i.e., management and forecast error) to achieve escapement thresholds or target exploitation rates under several harvest management strategies. His analysis showed that, given the uncertainty associated with estimating population productivity, and with implementing harvest management, imposing exploitation rate harvest objectives could result in more stable harvest than a fixed escapement goal strategy, without increasing the risk of population extinction.

Fieberg examined the probability of extinction (as measured over 50 years and compared with the probability under a minimal harvest condition) using several risk criteria, and found that it was consistently greater using a fixed escapement goal management strategy than under exploitation rate strategies regardless of the risk criterion used. The probability of extinction was significantly increased under the fixed escapement goal strategy when survival rates were biased (survival was actually lower than assumed). The exploitation rate strategies showed low or no increased probability of extinction under biased survival compared with unbiased estimates of survival. The reason is that the optimal parameters; i.e., harvest objectives (critical escapement threshold and exploitation rate designed to maximize harvest), under the fixed escapement goal strategy are close to the risk criteria as compared to those of the exploitation rate strategies. Therefore, even slight errors in the determination of the optimal parameters would result in probabilities of extinction greater than the risk criteria. The probability of extinction was greatly reduced when management buffers (i.e. setting escapement thresholds high to accommodate forecast and management error, or setting exploitation targets lower) were used such that the probability of extinction was low across all management strategies under unbiased survival rates. When survival rates were biased as may be the case in actual harvest management, the probability of extinction was once again much higher for the fixed escapement goal strategy compared with the exploitation rate strategies, although significantly lower than without the use of management buffers.

Expected harvest was generally equivalent for different management strategies[xv], except when forecast error was very high, because in this circumstance a high threshold is required to maintain low extinction risk. Exploitation rate strategies generally require 'trading' lower exploitation rate objectives for lower thresholds, thereby constraining harvest in high abundance years in exchange for allowing more harvest in low abundance years, again while maintaining low extinction risk. In general, increasing threshold parameters will result in more variable yields over time, but may also increase the average long-term harvest (relative to the same strategy employed with a lower threshold and lower exploitation rate parameter). Thus, there are tradeoffs in terms of maximizing catch versus reducing variability in catch that can be controlled to some extent by adjusting threshold parameters or adjusting exploitation rate parameters.

These tradeoffs are also inherent in the various harvest strategies. In a sense, the exploitation rate strategy, similar to that proposed in Alternative 1, trades lower escapement thresholds for lower exploitation rates when forecasted abundances are above these thresholds. As such, the exploitation rate strategy would harvest more fish at low forecasted abundances than the fixed escapement goal strategy of Alternatives 2 or 3, but fewer fish at high forecasted abundances.

The analysis clearly identifies the elevated extinction risk associated with failing to incorporate uncertainty in estimating populations parameters (e.g., productivity) when determining the optimal harvest threshold. It also points out the risk of underestimating the true critical escapement threshold for a population, whether the harvest strategy involves escapement thresholds or exploitation rates.

Regardless of the strategy, the methods used to optimize the strategies are likely to be as important as the strategy itself. Fieberg's analysis demonstrated the advantage of using management buffers. The results suggest that using buffers may provide a high degree of insurance against over-harvesting without a big loss in terms of realized harvest. Harvest benefits were very slightly decreased, while reducing the risk of extinction. The Proposed Action incorporates such buffers by setting the low abundance threshold substantially above the critical level, and by incorporating management error in the simulation model used to determine RERs.

[xv] Because Fieberg concluded that absolute zero harvest below an escapement threshold was impractical, all the management strategies he evaluated had some level of harvest allowed below the escapement threshold, although it was minimal under some strategies. Therefore, his escapement goal strategies were not exactly the same as those of Alternatives 2 and 3 in which no harvest occurs at abundances below the escapement threshold.

Another advantage of Alternative 1 compared to Alternative 2 (or 3) is that, at higher abundances, Alternative 1 would be expected to return even more chinook spawners than under fixed escapement goal management as exemplified by Alternative 2. The high abundance scenarios (Scenarios A and B) support this for some systems (e.g., the Stillaguamish River, Snohomish River, Puyallup River). As population abundance increases above current levels, this would be expected to be the case for more chinook river systems. Conversely, under significantly lower abundance, Alternative 1 would be expected to return fewer spawners than under fixed escapement goals for Alternatives 2 or 3, although the current modeling of Scenarios B and D do not reflect this even at a 30 percent reduction in abundance from current levels.

Indirect Effects of Alternative 2 (Escapement Goal Management at the Management Unit Level or Alternative 3 (Escapement Goal Management at the Population Level) on Listed Chinook and Chum Salmon Populations

The direct effects of predicted spawning escapement for Alternative 2, Scenario B (considered the most likely abundance scenario) compared to Alternative 1, Scenario B were predicted to be of a low to moderate beneficial nature for 11 of the 22 populations in the listed Puget Sound Chinook Evolutionarily Significant Unit. (Modeled results of spawning escapement showed an increase from 2% to 26%.) Given favorable river and marine survival conditions, and fishing regimes resembling those in place prior to the action, these increases could result in low to moderate increases in spawning returns. However, similar decreases in exploitation rates for some of these same chinook salmon populations observed in recent years have not been accompanied by increases in natural-origin spawners. This suggests that habitat factors may be the primary constraint on natural production (NMFS 2004 [4(d) determination]), and therefore increases in parental escapement would not result in increased abundance in subsequent generations.

Modeled results of changes in chinook salmon spawning escapement for the remaining populations varied. Most notably, escapement was predicted to decline by 60 percent for the North Fork and South Fork Stillaguamish chinook salmon populations. Escapement of the Puyallup River fall and White River Spring chinook salmon populations both were predicted to decline substantially (50% and 31%, respectively). Changes of these magnitudes would be much more likely to have measurable effects on abundance and escapement of the subsequent brood years. As noted in Subsection 4.3.1.2, however, escapements of the North Fork Stillaguamish, Puyallup and White River chinook salmon populations under Alternative 2 were predicted to meet current-condition escapement goals. Therefore, it is not necessarily accurate to assume that the indirect effect of Alternative 2 would be substantially negative.

The indirect effects of Alternative 3 would be essentially the same as Alternative 2, with the exception that the Stillaguamish chinook salmon management unit, where escapement was predicted to decline 60 percent relative to Alternative 1 under Alternative 2, would increase by approximately 7 percent relative to Alternative 1, under Alternative 3.

Fixed escapement goal management strategies, as in Alternative 2 or 3, are less robust to uncertainties in key parameters like survival and management error~~. Given the imprecision of abundance forecasts, this could be an important advantage~~ (Fieberg 2004 ~~*in press*~~).

Indirect Effects of Alternative 4 (No Fishing) on Listed Chinook and Chum Salmon Populations

The direct effects of Alternative 4 (No Fishing) would be an increase in escapement for all Puget Sound chinook salmon populations relative to Alternative 1 (the Proposed Action). In North Puget Sound and the Strait of Juan de Fuca, increases in chinook salmon escapement would be very similar to the increases under Alternative 2 or 3. In South Puget Sound and Hood Canal, increases in chinook salmon escapement are predicted to range from 5 percent for the Mid-Hood Canal chinook salmon population, to 190 percent for the Nisqually chinook salmon population. In addition to the substantial increase in spawning escapement for the Nisqually chinook salmon population, increases of 75 percent for the Green River population, 31 percent for the Puyallup River population, and 92 percent for the Skokomish River population were predicted by the model. Increased escapements of this magnitude could result in moderate to substantial increases in the spawning escapement of subsequent brood years. However, there is also a possibility that escapements substantially in excess of current-condition escapement goals would result in decreased survival owing to overcrowding of available freshwater spawning and rearing habitat, and increased competition for food. However, much less severe decreases in exploitation rates for some of these same populations observed in recent years have not been accompanied by increases in natural-origin chinook salmon spawners. This suggests that habitat factors may be the primary constraint on natural production (NMFS 2004 [4(d) determination]), and therefore increases in parental escapement would not result in increased abundance in subsequent generations.

Indirect Effects of Alternative 2 or 3 on Other Salmon Species

As noted in Subsections 4.3.2.2 and 4.3.2.3, Alternative 2 or 3 would substantially increase escapement of coho, pink, and fall chum salmon relative to Alternative 1. Modeling results predicted that overall escapement of naturally-spawning fish would increase from 44 percent to 136 percent depending on the species and the harvest management alternative selected. While this could have the effect of substantially increasing escapement of subsequent brood years, modeled escapements in many management units substantially exceed current-condition escapement goals, and could result in decreased productivity. For many coho salmon management units, exploitation rate objectives are based on stock recruit functions which would predict that large increases in escapement would not result in substantial increases in progeny (personal communication via e-mail from William Beattie to The William Douglas Company, February 17, 2004). There would be similarly large increases in the escapement of hatchery-origin spawners, with the likely result that there would be increased straying of hatchery fish to the spawning grounds. The indirect effects on sockeye populations would be low or none. Indirect effects on steelhead populations would be low or none owing to the very small changes in catch on this species under either Alternative 2 or 3.

4.3.8.2 Cumulative Effects of the Proposed Action or Alternatives on Fish Species

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR1508.7). For the purpose of this discussion, the terms "effects" and "impacts" will be considered synonymously with "consequences," and consequences may be negative or beneficial. This subsection presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action on fish resources in the context of other local, state, tribal, and federal management activities in the Puget Sound region.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative effects analysis is predicated on a review of laws, policies, regulations, and plans that specifically pertain to fish-related management activities or that have an indirect negative or beneficial effect on fish resources. These laws, policies, regulations, and plans are described in Section 1 and Appendix F. Due to the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or that will occur in the future in a quantitative manner. By reviewing applicable laws, policies, regulations, and plans, the analysis captures the objectives of management activities that are occurring or are planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on fish resources. Table 4.3.8.2-1 summarizes the potential cumulative effects of implementing the Proposed Action or alternatives with the effects of these existing plans, policies, programs, and laws.

The Proposed Action is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear. As shown in Table 4.3.8.2-1, the RMP would be consistent with the intent and policies of each of the federal, tribal, state, and local plans, programs, and laws reviewed for the cumulative effects analysis, and is predicted to enhance the benefits of these other measures as they relate to the conservation and/or enhancement of fish and wildlife habitat and fish populations.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004.

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Fish and Wildlife Coordination Act, 1956, as amended in 1964 (FWCA).	The FWCA recognizes "the vital contribution of our wildlife resources to the Nation, the increasing public interest and significance thereof due to expansion of our national economy and other factors, and to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation."	The Resource Management Plan would allow the harvest of salmon in coordination with ongoing conservation and rehabilitation efforts for chinook salmon. With an estimated value of $35 million ($16.2 million commercial plus $18.8 million recreational), the Puget Sound fishing industries are important to the Nation's economy. The Proposed Action would be consistent with the FWCA by recognizing the vital contribution of Puget Sound chinook salmon to the Nation and our national economy. It is predicted that implementation of the Resource Management Plan, in combination with the FWCA, would strive to balance considerations of the national economy, while also providing for fish conservation.
Washington State Shoreline Management Act of 1971 (SMA).	The SMA was adopted in Washington in 1972 with the goal of "prevent[ing] the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The provisions of this law are designed to guide the development of the shoreline lands in a manner that will promote and enhance the public interest. The law expresses the public concern for protection against adverse effects to public health, the land and its vegetation and wildlife, and the aquatic life of the waters.	Rearing habitat within shoreline areas of Washington State is essential to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the SMA by ensuring that harvest works in concert with habitat protection efforts under the SMA. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the SMA, would protect fish from adverse effects associated with uncoordinated and piecemeal development of the state's shorelines.
The National Marine Sanctuaries Act. Also known as Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 **(MPRSA)**.	The MPRSA authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or a esthetic qualities as National Marine Sanctuaries. One of the purposes and policies of the MPRSA is "to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes."	Protecting the marine environment where chinook salmon mature is important to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the MPRSA by maintaining chinook salmon populations of the natural biological communities in the marine environment. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the MPRSA, would strive to restore and enhance natural habitats, populations, and ecological processes of fish.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Coastal Zone Management Act of 1972 (CZMA), as amended through The Coastal Zone Protection Act of 1996.	The CZMA declares the national policy is "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations by "the protection of natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone."	Chinook salmon are one of the Nation's resources within the CZMA's coastal zone. The Proposed Action would be consistent with the CZMA by encouraging preservation and protection of Puget Sound chinook salmon and their habitat within the coastal zone for existing and succeeding generations, and by ensuring that harvest is consistent with the production and capacity of the habitat. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the CZMA, would preserve, protect, restore or enhance the fish resources of the Nation's coastal zone.
Marine Mammal Protection Act of 1972, as amended through 1996 (MMPA).	The MMPA establishes a Federal responsibility to conserve marine mammals, with management vested in the Department of Commerce for cetaceans and pinnipeds other than walrus. The MMPA states that the "Secretary must undertake a program of research and development for improving fishing methods and gear to reduce to the maximum extent practical the incidental taking of marine mammals in commercial fishing." To meet this requirement, the "Secretary must issue regulations to reduce to the lowest practical level the taking of marine mammals incidental to commercial fishing operations." Secretary of Commerce has issued regulation that prohibits deterrent devices that might seriously injure or kill a marine mammal and for fishermen to report unintentional marine mammal mortality.	The Proposed Action would be consistent with the MMPA to conserve marine mammals because the fisheries would be in compliance with Department of Commerce regulations to reduce to the lowest practical level the take of marine mammals incidental to commercial fishing operations. Although not specifically addressed in the Resource Management Plan, Department of Commerce regulations require Puget Sound fishermen to use non-lethal deterrent devices and to report unintentional marine mammal mortality. As chinook salmon are prey of marine mammals, implementation of the Resource Management Plan, in combination with the MMPA, is predicted to potentially reduce the amount of available prey for marine mammals over what would have been available had the fisheries not occurred. It is also true that the fisheries reduce the number of salmon in the short term because they are removing fish, some of which would otherwise spawn. Over the long term, however, it is expected that the RMP will aid in the recovery of the populations by ensuring that enough fish escape to produce more in subsequent generations as habitat improves.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
The Endangered Species Act of 1973, as amended through December, 1996 (ESA).	The purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species…" On July 10, 2000, NMFS issued a rule under section 4(d) of the ESA (referred hereafter as the 4(d) Rule). The 4(d) Rule provided limits on the application of the take prohibitions; i.e., take prohibitions would not apply to the plans and activities set out in the rule if those plans and activities adequately address criteria of the rule, including that implementation and enforcement of the resource management plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs.	The Puget Sound Chinook Salmon ESU is listed as threatened under the ESA. The Proposed Action to implement the Puget Sound Chinook Salmon Resource Management Plan includes a condition that the Secretary of Commerce will determine whether the Resource Management Plan adequately addresses the criteria outlined in Limit 6 of the ESA 4(d) Rule. Consequently, the Proposed Action would be consistent with the ESA by meeting these criteria designed to foster goals and objectives of the ESA, including to avoid appreciably reducing the likelihood of survival and recovery of Puget Sound chinook salmon ESU. The ESA would not only have a beneficial impact to listed Puget Sound chinook salmon, but species listed under the ESA also include predators of chinook salmon such as bull trout and bald eagle. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the ESA, would potentially have both unquantifiable beneficial and adverse impacts on fish resources.
United States of America, Plaintiff, Quinault Tribe of Indians on its own behalf and on behalf of the Queets Band of Indians, et al., Intervenor-Plaintiffs, v. State of Washington, Defendant, Thor C. Tollefson, Director, Washington State Department of Fisheries, et al., Intervenor-Defendants, Case number C70-9213, February 12, 1974 (Boldt Decision).	The Boldt Decision reaffirmed the rights of Washington Indian tribes to fish in accustomed places, and allocated 50 percent of the annual catch to treaty tribes. Judge Boldt held that the government's promise to secure the fisheries for the tribes was central to the treaty-making process, and that the tribes had an original right to the fish, which they extended to white settlers. Judge Boldt ordered the state to take action to limit fishing by non-Indians. The court decision recognized that "assuring proper spawning escapement is the basic element of conservation involved in restricting the harvest of salmon and Steelhead." The decision further defined adequate production escapement as "… that level of escapement from each fishery which will produce viable offspring in numbers to fully utilize all natural spawning grounds and propagation facilities reasonable and necessary for conservation of the resource…"	The objectives and principles of the Resource Management Plan jointly developed by the co-managers include compliance with the requirements of the Boldt Decision. The Boldt Decision would not have an appreciable effect on the total harvest, but addresses which party and where the harvest can occur. The Boldt Decision encourages the conservation of the species. The Resource Management Plan would conserve the productivity, abundance, and diversity of chinook salmon populations within the ESU. Therefore, it is predicted that implementation of the Resource Management Plan, in combination with the Boldt Decision, would have a beneficial impact on fish resources.

1 Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area:
2 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
State of Washington, Chapter 76.09 of the Revised Code of Washington (RCW), Forest Practices Act (FPA), 1974.	The FPA defines a plan to protect public resources while assuring that Washington continues to be a productive timber-growing area. The FPA regulates activities related to growing, harvesting or processing timber on all local government, state and private forest lands. The Washington Forest Practices Board was established in 1975 by the Legislature under the State Forest Practices Act. By law, the board is charged with establishing rules to protect the state's natural resources while maintaining a viable timber industry. Those rules, as embodied in the Washington Administrative Code (WAC), specifically consider the effects of various forest practices on fish, wildlife and water quality, as well as on capital improvements of the state or of its political subdivisions.	The Proposed Action would be consistent with the intent of the FPA to protect the natural resources of Washington State. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the FPA, would have a net beneficial impact on fish resources.
The Clean Water Act, 1977, (CWA). A 1977 amendment to the Federal Water Pollution Control Act (FWPCA) was titled "The Clean Water Act."	The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. As stated in the CWA, maintaining or restoring water quality "provides for the protection and propagation of fish, shellfish, and wildlife…"	The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on the Nation's water quality. Primarily because the CWA would maintain water quality that provides for the protection and propagation of fish, it is predicted that implementation of the Resource Management Plan, in combination with the CWA, would have a net beneficial impact on fish resources.
The Treaty between the Government of Canada and the Government of the United States of America concerning Pacific Salmon, 1985, including 1999 revised annexes (Pacific Salmon Treaty).	The Pacific Salmon Treaty calls on the U.S. and Canada (Parties) to conduct its fisheries as to "prevent overfishing and provide for optimum production." The Pacific Salmon Treaty defines "overfishing" as "fishing patterns which result in escapements significantly less than those required to produce maximum sustainable yields [MSY]." Annex IV, Chapter 3, Chinook Salmon of the Pacific Salmon Treaty further states that the Parties shall establish a chinook management program that "sustains healthy stocks and rebuilds stocks that have yet to achieve MSY or other biologically-based escapement objectives." Salmon subject to the Pacific Salmon Treaty includes Pacific salmon stocks which originate in the waters of one Party and subject to interception by the other Party.	Puget Sound chinook salmon are intercepted in Canadian fisheries under the authority of the Pacific Salmon Treaty. The Resource Management Plan accounts for all sources of fishery-related chinook salmon mortality, including mortality related to Canadian fisheries. Although the Resource Management Plan would allow exploitation rates that would result in escapements less than those required to produce maximum sustainable yields in some years, the Resource Management Plan would, overall, sustain healthy populations and rebuild stocks toward maximum sustainable yield. Consequently, the Proposed Action would be consistent with the Pacific Salmon Treaty. Accordingly, it is predicted that the implementation of the Resource Management Plan, in combination with the Pacific Salmon Treaty, would have a net beneficial impact on fish resources.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
State of Washington, Chapter 36.70A RCW Growth Management – Planning by Selected Counties and Cities. Commonly referred to as the Growth Management Act **(GMA)**. Adopted by the state in 1990.	The GMA guides the development and adoption of comprehensive land use plans and development regulations of counties and cities within the state of Washington. The goals of the GMA include: "[m]aintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries" and "[p]rotect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water."	The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on Washington State water quality. It is predicted that implementation of the Resource Management Plan would provide protection for fish conservation, and would not conflict with planned growth objectives of the GMA.
Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, commonly referred to as the Northwest Forest Plan **(NFP)**, 1994.	The NFP is an integrated, comprehensive design for ecosystem management, intergovernmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. The management direction of the NFP consists of extensive standards and guidelines, including land allocations that comprise a comprehensive ecosystem management strategy. Aquatic conservation strategy objectives outlined in the NFP (Attachment A of the NFP) include, but are not limited to: "Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted;" and, "Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities."	The Proposed Action would be consistent with the intent of NFP to maintain and restore the distribution, diversity, and complexity of watersheds. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the NFP, would have a net beneficial impact on fish resources.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Magnuson-Stevens Conservation and Management Act, as amended through October 11, 1996 (MSCMA).	The stated purpose of the MSCMA is "to promote domestic commercial and recreational fishing under sound conservation and management principles." The MSCMA is "to provide for the preparation and implementation, in accordance with national standards, of fishery management plans which will achieve and maintain, on a continuing basis, the optimum yield from each fishery." The MSCMS defines the term "optimum," with respect to the yield from a fishery, as the amount of fish which -- a) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; b) is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and c) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery. The National Standards that serve as the overarching objectives for fishery conservation and management include:	Based on consistency with the National Standards addressed below, it is predicted that implementation of the Resource Management Plan, in combination with the MSCMA, would have a net beneficial impact on fish resources.
	• Conservation and management measures shall prevent overfishing. The terms "overfishing" and "overfished" mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis.	• The Resource Management Plan provides for rebuilding to a level consistent with producing the maximum sustainable yield in the fishery. Consequently, the Proposed Action would be consistent with the National Standard that the management plan "shall prevent overfishing," as defined in the MSCMA.
	• Conservation and management measures shall be based upon the best scientific information available.	• The objectives of the Resource Management Plan include adequately addressing the criteria of a management plan under Limit 6 of the ESA 4(d) Rule. ESA requires the Secretary of Commerce to make such determinations on the basis of the best scientific and commercial data available. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to use the best scientific information available.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Magnuson-Stevens Conservation and Management Act, as amended through October 11, 1996 (MSCMA), *continued*	• To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated populations of fish shall be managed as a unit or in close coordination.	• For harvest management purposes, the Resource Management Plan defines 15 Puget Sound chinook salmon management units. The Resource Management Plan defines a management unit as a "stock or group of [chinook salmon] stocks which are aggregated for the purpose of achieving a management objective." The Resource Management Plan places limits to the cumulative fishery-related mortality to each Puget Sound chinook salmon population or management unit throughout its entire range. Thus, the Resource Management Plan accounts for all sources of fishery-related chinook salmon mortality throughout its range. The Proposed Action would be consistent with the National Standard of the MSCMA to manage populations throughout its range.
	• Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.	• As outlined in the Resource Management Plan, in managing fisheries in-season, the co-managers would implement guidelines established during the pre-season planning process to meet conservation requirements. However, these guidelines could be modified in-season based on in-season assessments of effort, catch, abundance, and escapement, while still meeting conservation requirements. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to allow contingencies in fisheries.
	• Conservation and management measures shall minimize by-catch.	• The Resource Management Plan is based on limits to the cumulative fishery-related mortality to each Puget Sound chinook salmon population or management unit. The Proposed Action would limit the cumulative mortality, which includes by-catch, to these limits. Consequently, the Proposed Action would be consistent with the National Standard of the MSCMA to minimize by-catch.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Gravel to Gravel, Regional Salmon Recovery Policy for the Puget Sound and the Coast of Washington, Western Washington Treaty Tribes, July 25, 1997 (Gravel to Gravel Policy).	Major elements of the Gravel to Gravel Policy are to provide habitat protection and restoration, ensuring abundant spawners, managing fisheries, and integrating hatchery production.	The Proposed Action would be consistent with the Gravel to Gravel policy of managing fisheries to ensure abundant spawners. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the Gravel to Gravel Policy, would have a beneficial impact on fish resources.
Policy of Washington Department of Fish and Wildlife and Western Washington Treaty Tribes Concerning Wild Salmonids (Wild Salmon Policy). Adopted by Washington Fish and Wildlife Commission on December 5, 1997. (Despite the title, the tribal governments have not adopted this Wild Salmon Policy.)	The stated goals of the Wild Salmon Policy include restoring Washington stocks of wild salmon and steelhead to healthy, harvestable runs by "managing commercial and sport fishing to ensure enough wild runs return to spawn while providing fishing opportunities where possible."	The Proposed Action would be consistent with the Wild Salmon Policy's intent to manage commercial and recreational fishing to ensure enough wild salmon return to spawn while providing fishing opportunities where possible. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the Wild Salmon Policy, would have a beneficial impact on fish resources.
Statewide Strategy to Recover Salmon, September 21, 1999 (SSRS).	The goal of the SSRS is to "[r]estore salmon, steelhead, and trout populations to healthy and harvestable levels and improve the habitats on which fish rely." The SSRS is the long-term vision or guide for salmon recovery within the State of Washington.	The Proposed Action would be consistent with the intent of SSRS to restore salmon populations to healthy and harvestable levels. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the SSRS, would have a beneficial impact on fish resources.
Local Plans, Policies, and Programs	Local activities that influence cumulative effects to fish include, but are not limited to: **Water Supply Projects:** Local water departments operate and maintain water reservoirs, pump stations, and water mains to deliver drinkable water to their customers. Local projects have minimized the adverse impacts of water withdrawal by installing additional water gauges to monitor flows and regulate water use, reducing water intake during critical environmental periods, and by purchasing existing water rights to return water to the system.	Many of these local activities are conducted in cooperation with federal, tribal, and state actions. The fisheries that would be allowed by the Resource Management Plan are predicted to have minimal to negligible effect on Washington State water quality. Because many of these local plans, policies, and programs would maintain water quality that provides for the protection and propagation of fish, it is predicted that the implementation of the Resource Management Plan, in combination with local plans, policies, and programs, would have a net beneficial impact on fish resources.

Table 4.3.8-1. Federal, Tribal, Washington state, and local plans, policies, and programs that influence fish within the Puget Sound Action Area: 2004 *(continued)*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of earliest to most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Local Plans, Policies, and Programs, *continued*	**Levee Maintenance:** A levee is a natural or manmade structure, usually earthen or riprap, which parallels the course of a river. It functions to prevent flooding of the adjoining countryside. However, it also confines the flow of the river resulting in higher, faster water flow. In recent years, local levee maintenance projects have included setting back or removing levees. **Stormwater Management:** Surface water runoff results from rainfall or snow melt that does not infiltrate the ground or evaporate due to impervious surfaces. instead, this runoff flows onto adjacent land, or into watercourses, or is routed into storm drainage collection systems managed by local entities. Local cities and counties are in the process of developing watershed plans, subbasin plans, and revising codes to minimize the adverse impacts of surface water runoff. **Wastewater Treatment Projects:** Municipal wastewater treatment plants process domestic sewage, and commercial and industrial wastewaters. Stormwater and groundwater infiltration may also enter wastewater treatment plants, though efforts are being made to segregate these flows. Local cities and counties are in the process of developing facilities plans and revising codes to minimize adverse impacts associated with wastewater treatment projects. **Salmon Recovery Efforts:** Local communities are undertaking activities to protect listed species and their habitat. Examples of activities conducted include, but are not limited to: reducing barriers to fish passage; improving habitat forming processes; increasing channel diversity; improving estuarine habitat; and enhancing streamside vegetation. **Watershed Conservation Plans:** As mandated by the 1998 state of Washington Watershed Management Act and Salmon Recovery Planning Act, counties are conducting watershed planning to address water quality, water quantity, and salmon habitat issues.	

4.4 Tribal Treaty Rights and Trust Responsibility

This section qualitatively evaluates the Proposed Action and alternatives with respect to their impact on the ability of the Puget Sound tribes to exercise their treaty rights to harvest salmon. Subsection 3.4, Tribal Treaty Rights and Trust Responsibilities – Affected Environment, described how these treaty rights were interpreted and affirmed by federal courts in U.S. v. Washington, and subsequent judicial oversight of the tribes' co-management role and harvest allocation. As explained in Subsection 3.4, the role of the federal government's oversight of Puget Sound fisheries is to assure that treaty rights are protected by federal, state, and local government entities, and to ensure that harvest actions implemented by the co-managers meet the requirements of the Endangered Species Act. The following discussion also evaluates the implications under federal trust responsibility of implementing the Proposed Action or one of the alternatives.

The substantial negative consequences of Alternative 2, 3, or 4 are presented here in a legal context, relative to the scope of conservation measures that are granted to NMFS as it implements the Endangered Species Act, complies with treaty rights, and fulfills its trust responsibility. The reader is referred to Subsections 4.5, Treaty Indian Ceremonial and Subsistence Salmon Uses; 4.6, Economic Activity and Value; and 4.7, Environmental Justice, of this Environmental Impact Statement for more detailed discussion of the economic and cultural consequences to the Puget Sound tribes.

The following comparison of the impacts of the four alternatives is based on Scenario B, which assumes that the abundance of Puget Sound chinook salmon will be similar to that projected in 2003, and that intercepting fisheries in British Columbia (Canada) and Alaska will harvest at the maximum level allowed under the Puget Salmon Treaty (PST) Annex 4 Chapter 3. Though the different abundance and northern fishery scenarios examined elsewhere in this Environmental Impact Statement imply different harvest levels in Puget Sound, the difference among alternatives with respect to qualitative impacts on the exercise of treaty rights would not change.

4.4.1 Alternative 1 – Proposed Action/Status Quo

Implementation of Alternative 1 would have low or no impact on treaty fisheries as they are currently conducted. Provided that the abundance of salmon stocks is sufficient to allow harvestable surpluses of the magnitude modeled under this alternative, the tribes are predicted to be able to continue accessing their usual and accustomed fishing areas, and to harvest substantial numbers of coho, sockeye, pink, chum salmon, and steelhead (see Table 4.7-5 in Subsection 4.7, Environmental Justice). The chinook salmon conservation measures contained in the Resource Management Plan (Appendix A to this

Environmental Impact Statement) imply relatively moderate constraints on access to these species, in order to reduce incidental impact to listed chinook salmon. Under Alternative 1, chinook salmon harvest would be substantially restricted, relative to historical levels, because of conservation requirements necessary to protect weak chinook populations. However, these restrictions would be voluntarily adopted by the tribes, in consultation with the State of Washington (Washington Department of Fish and Wildlife), as co-managers of Puget Sound fisheries.

Alternative 1 meets the requirement of the Secretarial Order that the restriction: 1) does not discriminate against Indian activities, and 2) incorporates voluntary tribal measures to achieve the necessary conservation purpose (Secretarial Order Number 3206, June 5, 1997). Alternative 1 would comport with the legal requirement that restriction on treaty fisheries be implemented in the least restrictive manner necessary in order to continue tribal access to naturally- and hatchery-produced salmon, while conserving natural populations. Therefore, Alternative 1 is predicted to be consistent with the federal trust responsibility to protect and provide tribal fishing opportunities. However, it is important to note that the Puget Sound tribes do not construe the fishing opportunity or harvest that would occur under Alternative 1 as satisfying treaty rights given the reduction in tribal harvest opportunity and catch that has occurred with the decline of Puget Sound salmon populations over the last several decades.

The proposed Resource Management Plan states that, for many populations, fishery exploitation rates would be constrained well below their exploitation rate ceiling- (see discussion in Section 2, Alternatives Including the Proposed Action, Subsection 2.3.1, Alternative 1 – Proposed Action/Status Quo), at the discretion of the co-managers, while units are recovering. This principle implies that tribes will voluntarily forego access to chinook salmon and other species from more productive and abundant units, in the interest of protecting weaker units, and promoting recovery of the Evolutionarily Significant Unit.

4.4.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, salmon fisheries in Puget Sound would be confined to terminal (i.e., freshwater) areas of Puget Sound and the Strait of Juan de Fuca. Terminal areas are defined as locations containing only populations returning to a single river system; such as, the Skagit River. Fisheries under the jurisdiction of the Pacific Fisheries Management Council, including Marine Catch Area 4B from May to September, would continue to operate. Puget Sound fisheries would also be constrained to meet harvest objectives for other species.

Reduction of treaty fishing opportunities to this extent would substantially preclude the exercise of treaty rights confirmed in U.S. v. Washington. Therefore, implementing Alternative 2 would be inconsistent with the federal trust responsibility, and would make the United States subject to litigation for damages. Alternative 2 would not implement measures that tribes have voluntarily proposed to achieve the necessary conservation purpose, whereas the Secretarial Order prescribes deference to these voluntary measures. Managing Puget Sound fisheries to achieve management-unit-specific escapement goals, and precluding marine fisheries as a means of certainty to achieve these goals, would place substantial constraint on tribal fisheries. The magnitude of harvest is predicted to be substantially reduced (78%) under Alternative 2, relative to Alternative 1. Though non-Indian recreational salmon harvest in freshwater is substantial for all management units, the majority of freshwater harvest, under Alternative 2 would be taken by Indian net fisheries.

Alternative 2 is predicted to substantially reduce access to usual and accustomed fishing areas and the exercise of treaty fishing rights compared to Alternative 1. For some tribes, the opportunity to harvest some species of salmon or steelhead is only available in marine areas. In some cases, harvest of those species would be precluded because they are either not produced in streams within their usual and accustomed fishing areas, or are produced at such low abundance that harvest would be precluded. Under Alternative 2, these species would be entirely unavailable to some tribes, effectively eliminating the exercise of treaty rights on those species by those tribes. Closure of pre-terminal marine fisheries due to the presence of commingled listed chinook salmon, would effectively preclude tribal access to harvest of Fraser River sockeye and pink salmon, and chum salmon originating in southern British Columbia. The Fraser River sockeye and pink fisheries, in particular, are of great economic and cultural consequence to tribes that would otherwise access this resource (see Subsections 4.5, Treaty Indian Ceremonial and Subsistence Salmon Uses; 4.6, Economic Activity and Value; and 4.7, Environmental Justice, of this Environmental Impact Statement).

4.4.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

The fishing regime envisioned by Alternative 3 would limit the exercise of treaty-reserved fishing rights to a greater extent than under Alternative 2, and would, therefore, be expected to result in a more substantial impact relative to Alternative 1. Reduction of treaty fishing opportunities to this extent would substantially preclude the exercise of treaty rights confirmed in U.S. v. Washington. Therefore, implementing Alternative 3 would be inconsistent with the federal trust responsibility, and would make the United States subject to litigation for damages. Alternative 3 would not implement measures that tribes have voluntarily proposed to achieve the necessary conservation purpose, whereas the Secretarial

Order (1997) prescribes deference to these voluntary measures. Managing Puget Sound fisheries to achieve management-unit-specific escapement goals, and precluding marine fisheries as a means of certainty to achieve these goals, would place substantial constraint on tribal fisheries.

Total salmon harvest is predicted to be 84 percent lower than under Alternative 1 (see Table 4.7.10). The escapement goals for individual populations prescribed by Alternative 3 infer lower harvestable abundance in the North Sound region, relative to Alternative 2, resulting in further reduction in fishing opportunity in the Stillaguamish River and Tulalip Bay (Marine Catch Area 8D).

Alternative 3 is predicted to substantially reduce access to usual and accustomed fishing areas and the exercise of treaty fishing rights compared to Alternative 1. As under Alternative 2, the closure of marine areas under Alternative 3 would effectively eliminate the exercise of treaty rights on some species by some Puget Sound tribes. Closure of pre-terminal marine fisheries due to the presence of commingled listed chinook salmon, would effectively preclude tribal access to harvest of Fraser River sockeye and pink salmon, and chum salmon originating in southern British Columbia. The Fraser River sockeye and pink salmon fisheries, in particular, are of great economic and cultural consequence to tribes that would otherwise access this resource (see Subsections 4.5, Treaty Indian Ceremonial and Subsistence Salmon Uses; 4.6, Economic Activity and Value; and 4.7, Environmental Justice, of this Environmental Impact Statement).

4.4.4 Alternative 4 – No Action/No Authorized Take

Under Alternative 4, no fishery-related mortality of listed Puget Sound chinook salmon would occur in salmon fisheries within the Puget Sound Action Area. Tribal salmon harvest would be limited to late-season fisheries for chum salmon and steelhead. Fisheries under the jurisdiction of the Pacific Fisheries Management Council, including troll fishing in Marine Catch Area 4B from May to September, would continue to operate. Implementing Alternative 4 would substantially limit the ability of Puget Sound tribes to obtain salmon or steelhead, since listed chinook are present, to a greater or lesser extent, throughout the year in most tribal usual and accustomed fishing areas and fisheries. Total salmon harvest is predicted to be reduced by 98 percent from the level predicted to occur under Alternative 1 (see Table 4.7.12). Implementing Alternative 4 would virtually eliminate access to usual and accustomed fishing areas in the Strait of Juan de Fuca and Puget Sound..

Elimination of treaty fishing opportunities on this broad scale would constitute substantial interference with Indian treaty fishing rights, which are property rights. The conservation standard of U.S. v. Washington and Secretarial Order Number 3206 require that any restriction on treaty fisheries be implemented in the least restrictive manner necessary to provide self-sustaining natural- and hatchery-produced salmon.. Such a severe limitation on the exercise of treaty rights would be inconsistent with the federal trust responsibility, and would make the United States subject to a damages claim. Alternative 4 would also fail to promote voluntary tribal measures to achieve the necessary conservation purpose as required by the Secretarial Order. The consequences of this alternative would thus have a substantial impact on the ability of Puget Sound tribes to exercise their treaty rights, and on the ability of the federal government to exercise its trust responsibility.

Alternative 4 could, legitimately, be eliminated from detailed examination in the Environmental Impact Statement because it implies violation of the trust responsibility of the federal government, and of the legal implication of Secretarial Order Number 3206 (1997), and thus is inconsistent with the purpose and need of the Proposed Action (see discussion in Section 2.3). However, the Settlement Agreement negotiated by the parties to Washington Trout v. Lohn, required analysis of a "No Take, No Harvest" alternative.

4.4.5 Indirect and Cumulative Effects

There are no predictable indirect effects on the exercise of treaty fishing rights by tribes which would not be directly affected by this action. Other than U.S. v. Washington and its various sub-proceedings, including its mandate for the Puget Sound Salmon and Steelhead Management Plan, there are no other relevant laws or policies that affect the exercise of treaty rights by Puget Sound or other tribes. Therefore, there are no indirect or cumulative effects to analyze for this element of the Environmental Impact Statement.

4.5 Treaty Indian Ceremonial and Subsistence Salmon Uses

This subsection analyzes the potential effects of the Puget Sound Chinook Harvest Resource Management Plan (the Proposed Action) or alternatives on the 17 treaty tribes that conduct ongoing treaty-based fishing activities within the Puget Sound Action Area, and the federally-recognized Snoqualmie and Samish tribes. The effects of the Proposed Action or alternatives on ceremonial and subsistence resource availability, access, and competition are considered in the context of the measurement guidelines described below.

Measurement Guidelines

In order to measure the degree of potential effect of the Proposed Action or alternatives, measurement guidelines are defined here, focusing on those factors that could affect tribal ceremonial and subsistence fishing.

Direct ceremonial and subsistence effects (occurring at the same time and place as the Proposed Action or alternatives) are predicated on changes in the availability of, access to, or competition for ceremonial and subsistence resources. Occurrences that could affect availability of fish resources to ceremonial and subsistence users include changes in resource abundance. Occurrences that could affect access to ceremonial and subsistence resources include regulatory barriers. Competition could increase from overall fishing effort being confined into a limited area that coincides with traditional tribal harvest areas.

In the context of the Proposed Action and alternatives evaluated in this Environmental Impact Statement, indirect ceremonial and subsistence effects (caused by the action but later in time or further removed in distance, but still reasonably foreseeable) include harvester responses to the direct effects (e.g., increased effort, costs and/or risk, or inability to go to traditional harvest places); a loss, reduction or increase of traditional food; effects on culturally significant activities (e.g., traditional harvest practices, participation or production; processing; distribution and sharing within and between tribes; ceremonial practices; transfer of knowledge/transmission of culture; satisfaction of eating traditional food/cultural preferences); and cultural identity.

For ceremonial and subsistence fishing, the following measurement guidelines are used, based on potential direct and indirect ceremonial and subsistence effects:

No Effect: No effect on availability of, access to, or competition for traditional ceremonial and subsistence resources.

- Would not affect key ceremonial and subsistence species (as measured by harvest effort, harvests, or cultural importance)
- Would not occur in an important use area for key ceremonial and subsistence resources
- Would be localized and represent a negligible geographic area relative to other areas of ceremonial and subsistence resource availability
- Would not result in a loss or reduction of traditional food
- Would not affect culturally significant activities
- Would not be measurable and/or expected, or would be of such a rare occurrence that it would be impossible to measure or detect potential effects.

Low: Small and infrequent effect on availability of, access to, or competition for traditional ceremonial and subsistence resources.

- Would not affect key ceremonial and subsistence species (as measured by harvest effort, harvests, or cultural importance)
- Would not occur in an important use area for key ceremonial and subsistence resources
- Would be localized and represent a small geographic area relative to other areas of ceremonial and subsistence resource availability
- Would result in a small and infrequent reduction of traditional foods
- Would affect culturally significant activities infrequently
- Would be measurable, but of small amount or infrequent occurrence
- Would not affect the overall pattern of ceremonial and subsistence uses.

Moderate: Moderate (e.g., within reasonable limits; medium, not excessive or extreme) effect on availability of, access to, or competition for traditional ceremonial and subsistence resources.

- Would affect key ceremonial and subsistence species (as measured by harvest effort, harvests or cultural importance)
- Would occur in an important use area for key ceremonial and subsistence resources
- Would represent a medium geographic area relative to other areas of ceremonial and subsistence resource availability
- Would result in a minor loss of traditional foods
- Would result in detectable effects on culturally significant activities
- Would be measurable at some level between low and substantial

- Could affect individual ceremonial and subsistence users, groups of users and/or the overall pattern of ceremonial and subsistence uses.

Substantial*:* Substantial (e.g., considerable in importance, value, degree, amount, or extent) effect on availability of, access to, or competition for traditional ceremonial and subsistence resources.

- Would occur frequently
- Would affect key ceremonial and subsistence species (as measured by harvest effort, harvests, or cultural importance)
- Would occur in an important use area for key ceremonial and subsistence resources
- Would represent a large geographic area relative to other areas of ceremonial and subsistence resource availability
- Would result in a measurable loss of traditional foods
- Would measurably affect culturally significant activities
- Would be measurable and/or expected
- Would substantially affect individual ceremonial and subsistence users, groups of users and/or the overall pattern of ceremonial and subsistence uses by communities.

4.5.1 Alternative 1 – Proposed Action/Status Quo

Alternative 1 would implement the ~~2003~~ Puget Sound Chinook Harvest Resource Management Plan during the 2005-2009 fishing seasons, a harvest management framework similar to that currently used by state and tribal co-managers within the action area since the year 2000. Under this alternative, all marine and freshwater areas currently fished would remain open to tribal fishers as long as the abundance of salmon populations remains sufficiently high to allow a harvestable surplus, and subject to in-season management to further constrain harvest of listed chinook salmon. The amount of fishing would vary from year to year depending on population status, but this alternative would allow some level of tribal fishing for ceremonial and subsistence purposes in all areas currently fished for coho, sockeye, pink, chum salmon, and steelhead.

Under the Proposed Action, tribal fishers would continue to have ceremonial and subsistence access to harvestable surpluses of all species, including chinook-directed harvests in terminal areas benefited by hatchery production. The Proposed Action would provide management flexibility that would allow tribes access to resources under variable abundance of chinook and other salmon species. Implementation of the Proposed Action would allow for continued ceremonial and subsistence harvests similar in size to the previous decade. However, Alternative 1 would impose considerable restriction on access to chinook salmon due to conservation measures that tribes voluntarily impose upon themselves.

Although Alternative 1 would be the most flexible of the four alternatives considered, and would provide tribes the greatest opportunity to harvest salmon for subsistence purposes, it would still represent a reduction in access and use from historical times. Overall, the Proposed Action would be a continuation of the status quo, and would have no direct adverse effect on tribal ceremonial and subsistence fishing within the action area because tribal fishing access would continue to be provided, and resource availability and competition for resources would not be affected.

This Environmental Impact Statement focuses on harvest levels predicted when Puget Sound chinook abundance and southern U.S. (SUS) fisheries are at the 2003 level, and intercepting Canadian/Alaskan fisheries are at the maximum allowed under the Pacific Salmon Treaty (Scenario B). Despite the variability in expected total harvest associated with lower abundance or northern fishery interceptions, it should be assumed that ceremonial and subsistence harvest would remain relatively constant for different northern fishery and abundance conditions, due to the high priority that tribal fishery managers place on meeting these essential requirements of tribal members and communities. In other words, it would be expected that commercial sales would be reduced, if necessary, to meet these constant subsistence requirements.

4.5.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

The direct effect of Alternative 2 would be to eliminate tribal harvest opportunity in all marine salmon areas of Puget Sound, and to close or severely restrict opportunity in the Nooksack and Skagit Rivers. Because many tribes depend on marine-area fisheries for a significant part or all of their ceremonial and subsistence harvest, implementation of Alternative 2 would substantially reduce the availability of salmon for ceremonial and subsistence use,compared to availability under Alternative 1. All species of salmon have equal cultural importance to tribes, are key ceremonial and subsistence resources, and the different species are harvested depending upon individual and tribal preferences for ceremonial and personal or family consumption. For some tribes, species of salmon or steelhead that would be available under Alternative 1 would no longer be available for harvest with Alternative 2, because they either would not be produced in streams within tribal usual and accustomed fishing areas, or they would be produced at such low abundance that harvest would not be allowed.

Total salmon harvest in Puget Sound would be predicted to fall 78 percent with Alternative 2 (Scenario B), relative to Alternative 1. Total harvest of would fall 36 percent for chinook salmon, 60 percent for coho, 100 percent for sockeye, 85 percent for pink salmon, and 68 percent for chum. Within regions, total salmon harvest is predicted to decline 96 percent in the Strait of Juan de Fuca, 90 percent in North Sound, 58 percent in South Sound, and 31 percent in Hood Canal (see Table 4.7.8 in Subsection 4.7, Environmental Justice). The change in the number of salmon used for subsistence purposes cannot be quantified precisely from this comparison of total harvest, but it suggests that tribal access to salmon for subsistence purposes would be substantially reduced in all regions, and that access to chinook and sockeye salmon in particular would be precluded in some regions.

Subsistence and ceremonial harvest is afforded highest priority by the tribes, and therefore is likely to be more constant than commercial harvest as abundance or access varies. However, the severe constraint of marine fishing opportunity envisioned under Alternative 2, would likely have substantial negative impact on the economic well-being of tribal members and communities, thereby increasing the need for subsistence harvest.

Under Alternative 2, harvesters would be unable to fish in all marine areas within Puget Sound, or in major freshwater rivers. Consequently, tribal fishing in remaining freshwater areas would increase compared to levels under Alternative 1. Because certain freshwater areas would remain open, this alternative could result in increased harvester competition in those areas as fishers seek salmon. Competition would be likely to increase among tribes that share common usual and accustomed freshwater fishing areas, and with recreational fishers that may seek increased fishing opportunities in freshwater areas.

4.5.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only.

Like Alternative 2, the direct effect of Alternative 3 would be to eliminate tribal harvest opportunity in all marine areas. However, Alternative 3 would further constrain tribal harvest opportunity in freshwater areas because regulating fishing to achieve population-specific escapement goals in the Stillaguamish and Snohomish Rivers would preclude access to chinook, pink, and coho salmon that would be available under Alternative 2. Opportunity in other freshwater areas would persist. Because many tribes depend on marine-area fisheries for a significant part or all of their ceremonial and subsistence harvest, implementation of Alternative 3 would substantially reduce the availability of salmon for ceremonial and subsistence use compared to availability under Alternative 1.

Total salmon harvest that would likely occur under Alternative 3 (Scenario B) is predicted to be 84 percent lower than under Alternative 1. Reductions in the total harvest of individual species would be slightly greater for chinook, coho, and pink salmon, and similar for sockeye, chum, and steelhead, relative to Alternative 2 (see Table 4.7.10 in Subsection 4.7, Environmental Justice). Reductions in total regional salmon harvest would be similar to Alternative 2, except in the North Sound region, where it is predicted that further reductions in chinook, coho, and pink salmon harvest would reduce total harvest by 99 percent. These negative effects are due to the preclusion of fishing in marine areas, where many tribes harvest a significant proportion, if not the majority, of their non-commercial salmon.

The actual reduction in the number of salmon that would be used for subsistence purposes under Alternative 3 cannot be precisely quantified. However, the preclusion of harvest in all marine areas, and in the Stillaguamish and Snohomish systems, would create substantial additional reduction in the availability of chinook, coho, and pink salmon in those areas, with particular impact to the tribes that fish in those areas. As noted for Alternative 2, as commercial harvest opportunity is reduced, the number of salmon required for subsistence purposes is likely to increase, as income and jobs are lost.

4.5.4 Alternative 4 – No Action/No Authorized Take

Under Alternative 4, all marine-area fisheries and most freshwater fisheries within the action area would be closed except for certain late-season freshwater fisheries for chum salmon (December – January) and steelhead (December – March). Total salmon harvest is predicted to decline 98 percent with Alternative 4, relative to Alternative 1. Fall chum harvest would be limited to the last two weeks of their spawning period, except in the Nisqually River, where a late-run of chum enters in December and January. Total chum salmon harvest is predicted to decline 92 percent, relative to Alternative 1, and would be effectively eliminated in the Strait of Juan de Fuca and Hood Canal regions (see Table 4.7.12 in Subsection 4.7, Environmental Justice). For those tribes that do not fish freshwater areas for chum salmon and steelhead, all fisheries would be closed.

The direct effect of Alternative 4 would be to substantially reduce availability and access to all riverine and marine salmon compared to Alternative 1. Access to chinook, coho, sockeye and pink salmon would be eliminated under Alternative 4, and only a few areas would remain open for fall chum salmon harvests (e.g., limited chum harvest in the Nooksack, Skagit, Green, Skokomish, and Puyallup Rivers; and unimpeded late-season chum harvest in the Nisqually River). As described in Subsection 3.5, Treaty Indian Ceremonial and Subsistence Salmon Uses – Affected Environment, all species of salmon are key ceremonial and subsistence resources (as measured by cultural importance), and different species are harvested depending upon individual and tribal preferences for ceremonial and personal or family consumption.

The areas closed to salmon fishing by Alternative 4 (e.g., the Puget Sound Action Area) are important historic and contemporary tribal harvest areas for ceremonial and subsistence salmon. Tribes rely on both marine and freshwater habitat of the action area for the harvest of ceremonial and subsistence salmon, and one Puget Sound tribe or another fishes the freshwater and marine areas within the Puget

Sound Action Area. For most tribes, the action area encompasses their entire usual and accustomed fishing grounds. The area that would be closed by Alternative 4 represents almost the entire geographic area of salmon availability. For these reasons, Alternative 4 would result in a substantial adverse direct effect on tribal ceremonial and subsistence fishing.

4.5.5 Indirect and Cumulative Impacts

4.5.5.1 Indirect Effects

Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects resulting from the direct effects on ceremonial and subsistence salmon uses include harvester responses to the direct effects (e.g., increased effort, costs and/or risk, and inability to go to traditional harvest places), the effects on an increase or loss of traditional foods, the effects on culturally significant activities associated with salmon uses (e.g., traditional harvest practices, participation or production; processing; distribution and sharing within and between tribes; ceremonial practices; transfer of knowledge/transmission of culture; satisfaction of eating traditional food/cultural preferences) and effects on cultural identity.

Alternative 1 – Proposed Action/Status Quo

Because the Proposed Action would result in no adverse effects due to reduced availability of or access to salmon aside from the conservation restrictions the tribes have voluntarily imposed upon themselves in consultation with the State of Washington, there would be no adverse indirect effects associated with Alternative 1.

Alternatives 2 or 3 – Escapement Goal Management

Tribal harvesters who rely on marine area fisheries would not be able to fish in their usual and accustomed fishing areas if Alternative 2 or 3 were implemented. Restrictions in several major freshwater rivers would greatly limit access to usual and accustomed fishing areas for those tribes.

With the closure of marine fishing areas and the restrictions on many rivers, implementation of the escapement goal type of management framework would be expected to result in a substantial reduction in the harvest of a traditional food important to Indian culture for tribes relying on those areas for salmon harvest. These tribal harvesters would likely be unable to harvest adequate numbers of salmon for the ceremonial and subsistence purposes described in the Affected Environment. Furthermore, the fishing closures anticipated under Alternatives 2 or 3 would effectively eliminate or significantly reduce culturally significant activities associated with salmon, including participation in traditional harvests; practicing traditional methods of harvesting and processing salmon, including community smokehouses; formal and informal distribution and sharing salmon within and between tribes; serving salmon for elder's dinners, community-wide dinners, or intertribal traditional dinners; reciprocity and exchanging salmon among kin and community members; sharing and informally distributing salmon – a practice that serves to bind the community in a system relationships and obligations; and gifting of salmon.

As described in the Affected Environment (Subsection 3.5, Treaty Indian Ceremonial and Subsistence Salmon Uses), salmon is an important traditional food that is intimately linked to ceremonial practices. Salmon is served during naming ceremonies, funerals, during one-year memorials after a death, and when students are honored. To tribes, a ceremony is incomplete if salmon is not present. With most salmon fishing opportunity precluded, conduct of first salmon ceremonies according to ancient tradition would be precluded in most areas. In addition, the satisfaction of eating traditional foods contributes to the overall well being of Indian people. Salmon is a favored food, and tribal members have developed preferences for various species as well as salmon caught in different waters (e.g., marine versus fresh or different rivers) or from different sections of a river. Alternatives 2 or 3 would result in a substantial loss of traditional foods for consumption by the Puget Sound tribes.

As described in the Affected Environment (Subsection 3.5), participation in a culture is at the core of cultural continuity and survival. Furthermore, in order to transfer cultural knowledge between generations, it is necessary for community members to participate in cultural practices. Harvesting, processing, preparing, and eating salmon in culturally-prescribed ways are important tribal activities for the transmission of a salmon fishing culture. Elders teach young people skills, and fishing is part of one's tribal education. The continual participation in culturally-significant activities serves to reinforce cultural values and ensure they are transmitted over time. For Indians within the action area, fishing for salmon has been for centuries, and continues to be, an integral part of tribal life. If access to harvesting salmon from marine waters were prohibited, as anticipated under Alternatives 2 or 3, Indian people within the action area who rely on marine salmon harvests would be subjected to being separated from a part of their cultural core, their cultural identity. Alternative 2 or 3 would eliminate marine salmon fishing and limit freshwater fishing to terminal fisheries. Without salmon fishing, associated cultural activities could not be practiced. Implementation of Alternative 2 or 3 would strike at the core of the cultural identity of the tribes within the action area who rely on salmon caught in marine areas.

Therefore, Alternative 2 or 3 would result in a substantial adverse indirect effect on tribal ceremonial and subsistence salmon fishing and use as compared with Alternative 1, because either would substantially affect individual ceremonial and subsistence users, groups of users, and the overall pattern of ceremonial and subsistence uses by communities.

Alternative 4 – No Action/No Authorized Take

Closure of salmon fishing in Puget Sound to the extent envisioned under Alternative 4, would, as stated above, essentially preclude exercise of Treaty fishing rights by the affected tribes. Salmon would continue to be available to tribal members from sources outside of Puget Sound and from conventional retail markets, but this acquisition would not substitute for salmon harvested locally, by local tribal members, from within their usual fishing areas. Obtaining salmon for ceremonial and subsistence purposes is inextricably associated with the practice of harvest according to ancient custom, on ancestral fishing grounds. Obtaining salmon from non-local sources would, in addition, necessarily incur relatively high cost and inconvenience, and could not, for most tribal people, be regarded as subsistence use.

With the closure of marine and freshwater fishing areas and access only to limited harvest of fall and winter chum and steelhead, Alternative 4would result in an abrupt and substantial reduction in the harvest of a traditional food important to Indian culture. To an even greater extent than Alternative 2 or 3, Alternative 4 would result in tribal harvesters being unable to harvest adequate numbers of salmon for the ceremonial and subsistence purposes described in Subsection 3.5 (Treaty Indian Ceremonial and Subsistence Salmon Uses – Affected Environment). Also to a greater extent than Alternative 2 or 3, fishing closures in Alternative 4 would affect a wide pattern of culturally-significant activities associated with salmon (including traditional harvest practices, participation in production, processing, distribution and sharing, ceremonial practices, transfer of culture, satisfaction of eating traditional foods, and cultural identity). All of the indirect effects described with Alternative 2 or 3 would apply to Alternative 4, and would be exacerbated by the near-total closure of tribal access to salmon within the action area.

Therefore, Alternative 4 would result in a substantial adverse indirect effect on tribal ceremonial and subsistence salmon fishing and uses compared to Alternative 1, because it would substantially affect individual ceremonial and subsistence users, groups of users and the overall pattern of ceremonial and subsistence uses by communities.

4.5.5.2 Cumulative Impacts

There are no predictable indirect effects on tribal use of salmon for subsistence or ceremonial purposes by Puget Sound tribes, or other tribes which would not be directly affected by this action. Other than

U.S. v. Washington and its various sub-proceedings, including its mandate for the Puget Sound Salmon and Steelhead Management Plan, there are no other relevant laws or policies that affect subsistence or ceremonial use by Puget Sound or other tribes. Therefore, there are no indirect or cumulative effects to analyze for this element of the Environmental Impact Statement.

4.6 Economic Activity and Value

The following sections describe the effects of implementing the Proposed Action and alternatives on commercial and sport fisheries and on the local and regional economy in the Puget Sound area. Economic impact indicators include sales by commercial salmon harvesters and processors, sales by businesses to sport fishing anglers, net economic values to commercial harvesters and processors, angler days, net economic values to sport anglers, and regional employment and personal income levels. Major effects on these indicators are summarized in Table 4.6-1, which characterizes the severity of predicted economic impacts. Based on an assessment of the annual variability in the economic impact indicators and on best professional judgment, the effects are characterized as follows: no impact (i.e., no change in economic impact indicators), low impact (i.e., less than a 2% change), moderate impact (i.e., 2 to 10% change), and substantial impact (more than 10% change). In addition, as described in the Section 4.3, *Fish*, implementing the Proposed Action could delay to some extent the recovery of several Puget Sound Chinook salmon populations. However, the effect that implementing Alternative 1 would have on the recovery period affecting the de-listing of the Puget Sound Chinook ESU cannot be determined with any reasonable degree of certainty. The harvest of Puget Sound Chinook salmon is only one of many factors that affect recovery and the incremental effect of harvest cannot be accurately isolated. Consequently, the extent to which the period of recovery is delayed cannot be determined, nor can it be determined whether the delay in the recovery of several populations within the multi-population Puget Sound Chinook ESU would affect the time in which the ESU would be de-listed. NMFS has stated that not all populations within the ESU would need to be at equally low risk in order to determine that the ESU was sufficiently recovered to be de-listed, and that there are probably multiple recovery scenarios. Nonetheless, a delay in de-listing could extend recovery efforts, which may impose additional costs on agencies responsible for recovery and additional costs for businesses and other entities to comply with take regulations. Although these additional costs cannot be estimated with any reasonable degree of accuracy, the costs could adversely affect businesses and other entities that impact Chinook salmon habitat in the Puget Sound area and the regional economy.

~~The following sections describe the effects of the Proposed Action and alternatives on salmon commercial fisheries, salmon sport fisheries, and regional economies in the Puget Sound area. Economic impact indicators include sales by commercial salmon harvesters and processors, sales by businesses to sport fishing anglers, net economic values to commercial harvesters and processors, angler days, net economic values to sport anglers, and regional employment and personal income levels. Major effects on these indicators are summarized in Table 4.6-1, which characterizes the~~

~~severity of predicted economic impacts. Based on an assessment of the annual variability in the economic impact indicators and on best professional judgment, the effects are characterized as follows: no impact (i.e., no change in economic impact indicators), low impact (i.e., less than a 2% change), moderate impact (i.e., 2 to 10% change), and substantial impact (more than 10% change).~~

The impact predictions presented in this section, which draw from the effects shown in Tables 4.6-2 through 4.6-19, are based on assumptions and data sources described in Appendix D. It should be noted that the direct employment effects of the Proposed Action and alternatives on the commercial salmon harvesting sector are evaluated using two measures: direct jobs and direct employment (Tables 4.6-3, 4.6-7, 4.6-11, and 4.6-15). "Direct jobs" represent both full-time and part-time jobs, whereas "direct employment" represents full-time equivalent (FTE) jobs. Nearly all of the "direct jobs" are part-time positions because of the seasonality of commercial salmon fishing in Puget Sound. Many persons engaged in commercial salmon fishing also participate in other fisheries and/or have other occupations. Consequently, the effect of changes in the salmon harvest associated with Alternatives 2, 3, or 4 on the number of "direct jobs" in commercial fishing is difficult to assess, and the numbers presented in Tables 4.6-3, 4.6-7, 4.6-11, and 4.6-15 should be interpreted as estimates of the number of potentially-affected persons employed in the salmon fishing industry,, as opposed to the number of persons who would necessarily become unemployed.

It also should be noted that estimated changes in net economic values to commercial salmon harvesters and processors under Alternatives 2, 3, or 4 exceed the estimates of net economic value under the Proposed Action/Status Quo. These results reflect consideration of the cost of unemployed labor and the potential loss of capital investments (i.e., boats and equipment) used for commercial fishing that would result from the substantial reductions in the commercial salmon harvest under Alternatives 2, 3, or 4. Substantial changes in the commercial harvest of salmon also would likely affect tribal commercial fishermen differently than non-tribal fishermen because of existing differences in alternative employment and capital investment opportunities; however, this issue, discussed more fully in Attachment C of Appendix D, and the associated effects on net economic values, could not be fully resolved for the analysis.

As discussed in Subsection 3.6, although nonuse values associated with the recovery of listed Puget Sound Chinook salmon are theoretically measurable and likely differ to some extent between the alternatives, existing data on recovery rates are too limited to reliably estimate these values.

4.6.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action would maintain commercial and sport fisheries at levels similar to conditions in the past.

4.6.1.1 Summary of Scenario Differences

Scenario A, which assumes high abundance and Canadian/Alaskan fisheries similar to those in 2003, is predicted generally to result in the highest levels of commercial and sport fishing activity, followed by Scenario B (high abundance with maximum Canadian/Alaskan fisheries); Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to 2003); and Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries).

The differences in commercial and sport fishing activity across the four scenarios are not predicted to be large. Compared to commercial salmon harvests under Scenario A, which are predicted to total an estimated 20.0 million pounds, Scenario B is predicted to result in harvests that would be about 99 percent of the levels under Scenario A; Scenario C harvests are predicted to be 98 percent of Scenario A levels; and Scenario D harvests are predicted to be 97 percent of Scenario A levels. In terms of sport fishing activity, Scenario B is predicted to result in angler trips that would be about 99 percent of the 1.4 million Scenario A trips; Scenario C trips are predicted to be 93 percent of Scenario A trips; and Scenario D trips are predicted to be 95 percent of Scenario A trips.

4.6.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Alternative 2, the management unit-based escapement alternative, is predicted to result in commercial and sport fishing activities at levels substantially below conditions in the past, but at levels greater than under Alternatives 3 or 4.

4.6.2.1 Summary of Scenario Differences

Under Alternative 2, Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003) is predicted to result in the highest levels of commercial and sport fishing activity, followed by Scenario B (high abundance with maximum Canadian/Alaskan fisheries); Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to 2003); and Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries). The differences in commercial and sport fishing activity are predicted to be relatively large across the four scenarios. Compared to commercial harvests under Scenario A, which are predicted to total an estimated 3.4 million pounds, Scenario B is predicted to result in harvests that would be approximately 99 percent of the levels under Scenario A; Scenario C harvests are predicted to be 84 percent of Scenario A levels; and Scenario D harvests are predicted to be 83 percent of Scenario A levels. In terms of sport fishing activity, Scenario B is predicted to result in angler trips that would be approximately 96 percent of the 231,900 Scenario A trips; Scenario C trips are predicted to be 71 percent of Scenario A trips; and Scenario D trips are predicted to be 67 percent of Scenario A trips.

4.6.2.2 Comparison of the Management Unit-Based Escapement Alternative (Alternative 2) to the Proposed Action

Relative to the Proposed Action, Alternative 2 is predicted to result in substantially reduced levels of commercial salmon harvests and sport fishing activity. Consequently, sales, employment, and personal income generated by commercial salmon harvests and sport fishing expenditures and net economic value also are predicted to be substantially smaller under Alternative 2 compared to the Proposed Action (Tables 4.6-5, 4.6-9, 4.6-13, 4.6-17 and 4.6-19). The reduction in net economic value (Table 4.6-18) associated with commercial fishing is predicted to be greater than the value under baseline conditions (the Proposed Action), because of the costs to society of unemployed labor resources and the expected loss in the value of capital investments (i.e., boats and equipment).

Under Alternative 2, Scenario B, commercial salmon harvests are predicted to be reduced by nearly 100 percent for non-tribal fishers and 72 percent for tribal fishers (Table 4.6-6), relative to levels under the Proposed Action, Scenario B. For sport fishing, angler trips are predicted to be reduced by 84 percent (Table 4.6-8). The severity of commercial and sport fishing effects is predicted to vary among the three economic regions within the Puget Sound Action Area. For non-tribal commercial salmon fishermen, harvest reductions are expected to be largest in the North Puget Sound and South Puget Sound/South Hood Canal regions, where commercial harvests are predicted to be eliminated; conversely, non-tribal commercial salmon harvests are expected to increase by 22 percent in the Strait of Juan de Fuca/North Hood Canal region (Table 4.6-6). For tribal commercial salmon fishermen, harvest reductions are predicted to range from 43 percent in the South Puget Sound/South Hood Canal region to 97 percent in the Strait of Juan de Fuca/North Hood Canal Region. Reductions in sport fishing trips are predicted to be substantial for all regions, ranging from 77 percent in the North Puget Sound region to 98 percent in the Strait of Juan de Fuca/North Hood Canal region (Table 4.6-8). For all regions, sport-fishing trips are expected to be eliminated in marine areas, with sport fishing for salmon limited to freshwater tributaries to Puget Sound. Under Scenario B, effects on regional sales, employment, and personal income are expected to follow the general direction and severity of regional changes in commercial harvests and sport fishing activity (Tables 4.6-7 and 4.6-9).

For Scenarios A, C, or D, Alternative 2 is expected to result in commercial and sport fishing impacts relative to the Proposed Action similar to those described for Scenario B. For non-tribal commercial salmon fishermen, reductions in harvests are anticipated to be nearly 100 percent under each scenario (Tables 4.6-2, 4.6-10, and 4.6-14). For tribal fishermen, harvest reductions are estimated to range from 72 percent under Scenario A (Table 4.6-2), to 76 percent under Scenarios C or D (Tables 4.6-10 and 4.6-14). Overall reductions in sport angler trips are predicted to range from 84 percent under Scenario A (Table 4.6-4), to 89 percent under Scenario D (Table 4.6-16).

In conclusion, the local economic effects of Alternative 2 under all scenarios are anticipated to be substantial and adverse relative to conditions under the Proposed Action for all three regions of the Puget Sound Action Area (Table 4.6-1). These effects would be most severe in communities dependent upon commercial fishing and sport fishing activities, and, potentially, in communities with seafood processing facilities. While substantially adverse in local areas, the adverse economic effects of Alternative 2 are anticipated to be low when viewed in the context of the overall economy of each region, because the estimated reductions in sales, employment, and personal income under the alternatives would be minor compared to total levels for each region. For example, total reductions in commercial and sport fishing-related employment under the worst case scenario (i.e., Scenario D) would be an estimated 621 full-time equivalent jobs in the North Puget Sound region, 368 jobs in the Strait of Juan de Fuca/North Hood Canal region, and 200 jobs in the South Puget Sound/South Hood Canal region (Table 4.6-17). Based on regional employment levels in 2000 (see Table 3.6-4), these job losses would represent 0.1 percent of the total jobs in the North Puget Sound region, 0.8 percent of the jobs in the Strait of Juan de Fuca/North Hood Canal region, and less than 0.1 percent of the jobs in the South Puget Sound/South Hood Canal region.

4.6.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Alternative 3, the population unit-based escapement alternative, is predicted to result in commercial and sport fishing activities at levels similar to Alternative 2, but substantially below past conditions.

4.6.3.1 Summary of Scenario Differences

Under Alternative 3, Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003) is predicted to result in the highest levels of commercial and sport fishing activity, followed by Scenario B (high abundance with maximum Canadian/Alaskan fisheries); Scenario C (30% reduction in abundance with Canadian/Alaskan fisheries similar to 2003); and Scenario D (30% reduction in abundance with maximum Canadian/Alaskan fisheries). The differences in commercial and sport fishing activity are relatively large across the four scenarios. Compared to commercial harvests under Scenario A, which would total an estimated 2.8 million pounds, Scenario B is predicted to result in harvests that would be about 99 percent of the levels under Scenario A; Scenario C harvests would be 90 percent of Scenario A levels; and Scenario D harvests would be 89 percent of Scenario A levels. In terms of sport fishing activity, Scenario B is predicted to result in angler trips that would be about 95 percent of the 177,500 Scenario A trips; Scenario C trips would be 76 percent of Scenario A trips; and Scenario D trips would be 71 percent of Scenario A trips.

4.6.3.2 Comparison of the Population Unit-Based Escapement Alternative (Alternative 3) to the Proposed Action

Relative to the Proposed Action, Alternative 3 is predicted to result in substantially reduced levels of commercial salmon harvests and sport fishing activity. Consequently, sales, employment, and personal income generated by commercial salmon harvests and sport fishing expenditures and net economic value also are predicted be substantially smaller under Alternative 3 compared to the Proposed Action (Tables 4.6-5, 4.6-9, 4.6-13, 4.6-17 and 4.6-19). Similar to Alternative 2, the reduction in net economic value (Table 4.6-18) associated with commercial fishing is predicted to be greater than the value under baseline conditions (the Proposed Action) because of the costs to society of unemployed labor resources and the expected loss in the value of capital investments (i.e., boats and equipment).

Under Alternative 3, Scenario B, the severity of regional commercial and sport fishing effects are predicted to be similar to those previously described for Alternative 2 for all regions other than the North Puget Sound region. Within the North Puget Sound region, reductions in tribal commercial harvests and sport fishing trips are predicted to be slightly more severe than under Alternative 2 (Tables 4.6-6 and 4.6-8). Effects on regional sales, employment, and personal income under Alternative 3, Scenario B, are predicted to follow the general direction and severity of regional changes in commercial harvests and sport fishing activity (Tables 4.6-7 and 4.6-9).

For Scenarios A, C, or D, Alternative 3 is expected to result in commercial and sport fishing impacts relative to the Proposed Action similar to those described for Scenario B. For non-tribal commercial salmon fishermen, reductions in harvests are anticipated to be nearly 100 percent under each scenario (Tables 4.6-2, 4.6-10, and 4.6-14). For tribal fishermen, harvest reductions are estimated to range from 77 percent under Scenario A (Table 4.6-2), to 79 percent under Scenarios C or D (Tables 4.6-10 and 4.6-14). Overall reductions in sport angler trips are predicted to range from 88 percent under Scenario A (Table 4.6-4), to 91 percent under Scenario D (Table 4.6-16).

In conclusion, the local economic effects of Alternative 3 under all scenarios are anticipated to be substantial and adverse relative to conditions under the Proposed Action for all three regions of the Puget Sound Action Area (Table 4.6-1). These effects would be most severe in communities dependent upon commercial fishing and sport fishing activities, and, potentially, in communities with seafood processing facilities. While substantially adverse in local areas, the adverse economic effects of Alternative 3 are anticipated to be low when viewed in the context of the overall economy of each region, because the estimated reductions in sales, employment, and personal income under the alternatives would be minor compared to total levels for each region. For example, total reductions in commercial and sport fishing-related employment under the worst case scenario (i.e., Scenario D) would be an estimated 645 full-time equivalent jobs in the North Puget Sound region, 370 jobs in the Strait of Juan de Fuca/North Hood Canal region, and 200 jobs in the South Puget Sound/South Hood Canal region (Table 4.6-17). Based on regional employment levels in 2000 (see Table 3.6-4), these job losses would represent 0.1 percent of the total jobs in the North Puget Sound region, 0.8 percent of the jobs in the Strait of Juan de Fuca/North Hood Canal region, and less than 0.1 percent of the jobs in the South Puget Sound/South Hood Canal region.

4.6.4 Alternative 4 – No Action/No Authorized Take

Alternative 4, the no authorized take alternative, would substantially limit commercial and sport fishing activities, resulting in activity levels substantially below conditions in the past or under Alternative 2 or Alternative 3.

4.6.4.1 Summary of Scenario Differences

Under Alternative 4, effects on commercial and sport fishing activity are predicted to be virtually the same across all four scenarios, with commercial salmon harvests of about 429,000 pounds and sport fishing activity of 4,300 trips.

4.6.4.2 Comparison of the No Action/No Authorized Take Alternative (Alternative 4) to the Proposed Action

Relative to the Proposed Action, Alternative 4 is predicted to eliminate almost all levels of commercial salmon harvests and sport fishing activity in the Puget Sound area. Consequently, sales, employment, and personal income generated by commercial salmon harvests and sport fishing expenditures and net economic value also are predicted be virtually eliminated (Tables 4.6-5, 4.6-9, 4.6-13, 4.6-17 and 4.6-19). Similar to Alternative 2 or Alternative 3, the reduction in net economic value (Table 4.6-18) associated with commercial fishing is predicted to be greater than the value under baseline conditions (the Proposed Action) because of the costs to society of unemployed labor resources and the expected loss in the value of capital investments (i.e., boats and equipment).

Under Alternative 4, Scenario B (high abundance with maximum Canadian/Alaskan fisheries), commercial salmon harvests are predicted to be reduced by 100 percent for non-tribal fishers and by 96 percent for tribal fishers (Table 4.6-6). Commercial salmon fishing is predicted to be virtually eliminated in the North Puget Sound and Strait of Juan de Fuca/North Hood Canal regions (Table 4.6-6). Within the South Puget Sound/South Hood Canal Region, tribal harvest is expected to be reduced by 91 percent compared to harvest levels under the Proposed Action. For sport fishing under Alternative 4 (Scenario B), total angler trips and net economic value would be reduced by more than 99 percent (Tables 4.6-8 and 4.6-19). Within all regions, sport fishing is predicted to be limited to a very small number of freshwater sport fishing trips (Table 4.6-8). Adverse effects on regional sales, employment, and personal income generated by changes in commercial harvests and sport fishing activity are predicted to be substantial in all regions (Table 4.6-9).

For Scenarios A (high abundance and Canadian/Alaskan fisheries similar to those in 2003); C (30% reduction in abundance with Canadian and Alaskan fisheries similar to 2003); or D (30% reduction in abundance with maximum Canadian and Alaskan fisheries), Alternative 4 is expected to result in commercial and sport fishing impacts relative to the Proposed Action virtually the same as those described for Scenario B, with commercial harvests and sport fishing trips virtually eliminated in all regions within the Puget Sound Action Area (Tables 4.6-2, 4.6-4, 4.6-10, 4.6-12, 4.6-14, and 4.6-16).

In conclusion, the local economic effects of Alternative 4 under all scenarios are anticipated to be substantial and adverse relative to conditions under the Proposed Action for all three regions of the Puget Sound Action Area (Table 4.6-1). These effects would be most severe in communities dependent upon commercial fishing and sport fishing activities, and, potentially, in communities with seafood processing facilities. While substantially adverse in local areas, the adverse economic effects of Alternative 4 are anticipated to be low when viewed in the context of the overall economy of each region, because the estimated reductions in sales, employment, and personal income under the alternatives would be minor compared to total levels for each region. For example, total reductions in commercial and sport fishing-related employment under the worst case scenario (i.e., Scenario D) would be an estimated 660 full-time equivalent jobs in the North Puget Sound region, 373 jobs in the Strait of Juan de Fuca/North Hood Canal region, and 276 jobs in the South Puget Sound/South Hood Canal region (Table 4.6-17). Based on regional employment levels in 2000 (see Table 3.6-4), these job losses would represent 0.1 percent of the total jobs in the North Puget Sound region, 0.8 percent of the jobs in the Strait of Juan de Fuca/North Hood Canal region, and less than 0.1 percent of the jobs in the South Puget Sound/South Hood Canal region.

4.6.5 Summary

In summary, compared to the Proposed Action, Alternative 4 is predicted to have the most severe effect on the commercial and sport harvest of salmon and on regional economic activity, followed by Alternatives 3 and 2.

Under Alternatives 2, 3, or 4 for all scenarios, the virtual elimination of marine fishing and substantial restrictions on freshwater fishing would be expected to greatly reduce statewide and regional economic activity associated with Puget Sound commercial and sport fisheries. Under Scenario B (high abundance with maximum Canadian/Alaskan fisheries), total statewide salmon harvester and processor sales generated by the Puget Sound fishery are predicted to fall from $26.9 million under the Proposed Action to $4.3 million under Alternative 2, $3.6 million under Alternative 3, and $438,000 under Alternative 4 (Table 4.6-9). For Scenario B, similar reductions, ranging from 85 percent under Alternative 2 to 98 percent under Alternative 4, are predicted to occur in total employment and personal income generated by commercial salmon fishing and processing (Table 4.6-9). Statewide economic effects resulting from reductions in sport fishing activity are predicted to be much less severe than effects resulting from reduced commercial harvests because, on a statewide level, net sport fishing-related effects would be generated only by reductions in trip-related spending by persons residing outside of Washington, who account for a small portion of total trips. Reductions in angler trips and trip-related expenditures by Washington residents would have little effect because changes in spending by residents would merely redirect money already in the state economy, resulting in no net economic effects. As a result, sales, employment, and personal income in Washington related to sport fishing in Puget Sound are predicted to decline by only about 6 percent for all alternatives under Scenario B compared to levels under the Proposed Action (Table 4.6-9).

Among the three economic regions surrounding Puget Sound, all but the South Puget Sound/South Hood Canal region are predicted to lose more than 94 percent of the local and regional sales, employment, and personal income generated by commercial salmon fishing in the Puget Sound fishery under Scenario B of the three alternatives (Table 4.6-9). Reductions in commercial salmon fishing-related economic activity in the South Puget Sound/South Hood Canal region are predicted to range from 65 percent under Alternatives 2 or 3, to 95 percent under Alternative 4.

As with statewide effects, regional economic impacts resulting from reductions in sport fishing activity associated with the Puget Sound fishery are anticipated to be less severe than commercial fishing impacts. This is because economic effects in each region would result only from reductions in fishing trips and expenditures associated with out-of-region anglers who account for a relatively small percentage of angler activity. Under Scenario B, reductions in sport fishing-related economic activity (i.e., sales, employment, and personal income) are predicted to be largest in the Strait of Juan de Fuca/North Hood Canal region, ranging between 69 and 72 percent (Table 4.6-9). In the North Puget Sound region, reductions in sport fishing-related economic activity are predicted to range from about 21 percent under Alternative 2 to about 27 percent under Alternative 4. Reductions in economic activity in the South Puget Sound/South Hood Canal region are predicted to range from about 12 percent under Alternative 2 to about 15 percent under Alternative 4 (Table 4.6-9).

For Scenarios A (high abundance and Canadian/Alaskan fisheries similar to those in 2003); C (30% reduction in abundance with Canadian and Alaskan fisheries similar to 2003); or D (30% reduction in abundance with maximum Canadian and Alaskan fisheries), Alternatives 2, 3, or 4 are predicted to result in regional economic impacts relative to the Proposed Action similar to those described for Scenario B although effects are generally predicted to be greatest under Scenario D. For Scenarios A, C, or D, total statewide salmon harvester and processor sales generated by the Puget Sound fishery are predicted to fall from 84 to 87 percent with Alternative 2; 87 to 88 percent with Alternative 3; and 98 percent with Alternative 4 (Tables 4.6-5, 4.6-13, 4.6-17). Similar reductions, ranging from 84 to 87 percent with Alternative 2, to 98 percent with Alternative 4, are predicted to occur in total employment and personal income generated by commercial salmon fishing and processing (Tables 4.6-5, 4.6-13, and 4.6-17). Under Scenarios A, C, or D, sales, employment, and personal income in Washington related to sport fishing in Puget Sound are predicted to decline by only about 6 to 7 percent for all alternatives compared to levels under the Proposed Action (Tables 4.6-5, 4.6-13, and 4.6-17).

In conclusion, the local economic effects of Alternatives 2, 3, or 4 are predicted to be substantial and adverse relative to conditions under the Proposed Action for all three regions of the Puget Sound Action Area (Table 4.6-1). These effects would be most severe in communities dependent upon commercial fishing and sport fishing activities, and, potentially, in communities with seafood processing facilities. While substantially adverse in local areas, the adverse economic effects of the three alternatives would be low when viewed in the context of the overall economy of each region, because the estimated reductions in sales, employment, and personal income under the alternatives would be minor compared to total levels for each region. For example, total reductions in commercial and sport fishing-related employment under the worst case alternative and scenario (i.e., Alternative 4, Scenario D) would be an estimated 660 full-time equivalent jobs in the North Puget Sound region, 373 jobs in the Strait of Juan de Fuca/North Hood Canal region, and 276 jobs in the South Puget Sound/South Hood Canal region (Table 4.6-17). Based on regional employment levels in 2000 (see Table 3.6-4), these job losses would represent 0.1 percent of total jobs in the North Puget Sound region, 0.8 percent of jobs in the Strait of Juan de Fuca/North Hood Canal region, and less than 0.1 percent of jobs in the South Puget Sound/South Hood Canal region.

Table 4.6-1. Performance of economic indicators under alternatives 1-4 relative to conservation standards under scenarios 1-4.

	Alternative 2 Compared to Alternative 1								Alternative 3 Compared to Alternative 1								Alternative 4 Compared to Alternative 1							
	Scenario A		Scenario B		Scenario C		Scenario D		Scenario A		Scenario B		Scenario C		Scenario D		Scenario A		Scenario B		Scenario C		Scenario D	
	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent	Type	Extent
North Puget Sound:																								
Sales by commercial salmon harvesters & processors	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value of commercial salmon fishing	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sales by businesses to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sport fishing angler days	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional employment	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional personal income	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
South Puget Sound/South Hood Canal:																								
Sales by commercial salmon harvesters & processors	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value of commercial salmon fishing	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sales by businesses to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sport fishing angler days	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional employment	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional personal income	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Strait of Juan de Fuca/North Hood Canal:																								
Sales by commercial salmon harvesters & processors	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value of commercial salmon fishing	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sales by businesses to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Sport fishing angler days	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Net economic value to sport fishing anglers	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional employment	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S
Regional personal income	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S

Impact type:		Impact extent:	
Beneficial	B	No impact (0%)	O
Adverse	A	Low (<2%)	L
No impact	NI	Moderate (2%-10%)	M
		Substantial (>10%)	S

Table 4.6-2. Impacts to commercial harvest, commercial harvest value, and processing value.
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North:										
Non-Tribal										
Harvest (pounds)	5,567,330	3,032	-5,564,298	-99.9%	3,032	-5,564,298	-99.9%	0	-5,567,330	-100.0%
Harvest Value	$2,665,002	$1,434	-$2,663,568	-99.9%	$1,434	-$2,663,568	-99.9%	$0	-$2,665,002	-100.0%
Tribal										
Harvest (pounds)	6,725,730	643,255	-6,082,476	-90.4%	14,081	-6,711,649	-99.8%	13,312	-6,712,418	-99.8%
Harvest Value	$3,136,631	$218,197	-$2,918,434	-93.0%	$4,189	-$3,132,442	-99.9%	$3,874	-$3,132,758	-99.9%
Processing Value	$11,521,724	$537,194	-$10,984,530	-95.3%	$13,965	-$11,507,759	-99.9%	$10,390	-$11,511,334	-99.9%
South Puget Sound/South Hood Canal:										
Non-Tribal										
Harvest (pounds)	2,516,170	0	-2,516,170	-100.0%	0	-2,516,170	-100.0%	0	-2,516,170	-100.0%
Harvest Value	$627,257	$0	-$627,257	-100.0%	$0	-$627,257	-100.0%	$0	-$627,257	-100.0%
Tribal										
Harvest (pounds)	4,805,614	2,720,759	-2,084,856	-43.4%	2,720,759	-2,084,856	-43.4%	411,387	-4,394,227	-91.4%
Harvest Value	$1,757,387	$936,614	-$820,773	-46.7%	$936,614	-$820,773	-46.7%	$100,265	-$1,657,123	-94.3%
Processing Value	$6,604,154	$2,637,459	-$3,966,695	-60.1%	$2,637,459	-$3,966,695	-60.1%	$315,147	-$6,289,007	-95.2%
Strait of Juan de Fuca/North Hood Canal:										
Non-Tribal										
Harvest (pounds)	10,920	13,340	2,420	22.2%	13,340	2,420	22.2%	0	-10,920	-100.0%
Harvest Value	$5,132	$6,270	$1,138	22.2%	$6,270	$1,138	22.2%	$0	-$5,132	-100.0%
Tribal										
Harvest (pounds)	420,792	13,559	-407,233	-96.8%	13,559	-407,233	-96.8%	4,255	-416,537	-99.0%
Harvest Value	$292,912	$6,658	-$286,254	-97.7%	$6,658	-$286,254	-97.7%	$2,841	-$290,071	-99.0%
Processing Value	$513,111	$28,214	-$484,897	-94.5%	$28,214	-$484,897	-94.5%	$5,567	-$507,544	-98.9%
Statewide Total:										
[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area										
Harvest (pounds)	8,094,420	16,372	-8,078,048	-99.8%	16,372	-8,078,048	-99.8%	0	-8,094,420	-100.0%
ithin the region identified	$3,297,391	$7,704	-$3,289,688	-99.8%	$7,704	-$3,289,688	-99.8%	$0	-$3,297,391	-100.0%
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that										
Harvest (pounds)	11,952,137	3,377,573	-8,574,564	-71.7%	2,748,399	-9,203,737	-77.0%	428,954	-11,523,183	-96.4%
Harvest Value	$5,186,931	$1,161,469	-$4,025,462	-77.6%	$947,461	-$4,239,470	-81.7%	$106,979	-$5,079,952	-97.9%
Processing Value	$18,638,990	$3,202,867	-$15,436,123	-82.8%	$2,679,638	-$15,959,351	-85.6%	$331,105	-$18,307,885	-98.2%

Note: All dollar values are expressed in 2002 dollars.

Table 4.6-3. Direct economic impacts to the commercial fishing and salmon processing industries.
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	972.7	0.5	-972.2	-99.9%	0.5	-972.2	-99.9%	0.0	-972.7	-100.0%
Employment[2]	67.2	0.0	-67.1	-100.0%	0.0	-67.1	-100.0%	0.0	-67.2	-100.0%
Personal Income[3]	$1,725,198	$648	-$1,724,549	-100.0%	$648	-$1,724,549	-100.0%	$0	-$1,725,198	-100.0%
Tribal:										
Jobs[1]	1,590.3	110.6	-1,479.6	-93.0%	2.1	-1,588.1	-99.9%	2.0	-1,588.3	-99.9%
Employment[2]	76.1	7.8	-68.3	-89.7%	0.1	-76.0	-99.9%	0.1	-76.1	-99.9%
Personal Income[3]	$1,955,153	$179,310	-$1,775,843	-90.8%	$1,467	-$1,953,687	-99.9%	$1,304	-$1,953,850	-99.9%
Processing Sector:										
Employment[2]	181.5	9.6	-172.0	-94.7%	0.3	-181.3	-99.9%	0.2	-181.3	-99.9%
Personal Income[3]	$4,569,379	$241,311	-$4,328,068	-94.7%	$6,365	-$4,563,014	-99.9%	$4,922	-$4,564,457	-99.9%
South Puget Sound/South Hood Canal:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	228.9	0.0	-228.9	-100.0%	0.0	-228.9	-100.0%	0.0	-228.9	-100.0%
Employment[2]	7.4	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%
Personal Income[3]	$185,657	$0	-$185,657	-100.0%	$0	-$185,657	-100.0%	$0	-$185,657	-100.0%
Tribal:										
Jobs[1]	891.0	474.9	-416.1	-46.7%	474.9	-416.1	-46.7%	50.8	-840.2	-94.3%
Employment[2]	30.3	19.4	-10.9	-36.0%	19.4	-10.9	-36.0%	1.3	-29.0	-95.8%
Personal Income[3]	$761,987	$433,255	-$328,732	-43.1%	$433,255	-$328,732	-43.1%	$28,289	-$733,698	-96.3%
Processing Sector:										
Employment[2]	94.4	35.1	-59.3	-62.8%	35.1	-59.3	-62.8%	5.3	-89.1	-94.4%
a marina or launch area	$2,442,028	$908,621	-$1,533,406	-62.8%	$908,621	-$1,533,406	-62.8%	$136,498	-$2,305,529	-94.4%
Strait of Juan de Fuca/North Hood Canal:										
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.										
cause it is assumed that										
Jobs[1]	1.9	2.3	0.4	22.2%	2.3	0.4	22.2%	0.0	-1.9	-100.0%
Employment[2]	0.1	0.1	0.0	37.9%	0.1	0.0	37.9%	0.0	-0.1	-100.0%
Personal Income[3]	$2,180	$2,664	$483	22.2%	$2,664	$483	22.2%	$0	-$2,180	-100.0%
Tribal:										
Jobs[1]	148.5	3.4	-145.1	-97.7%	3.4	-145.1	-97.7%	1.4	-147.1	-99.0%
Employment[2]	5.0	0.1	-4.9	-97.3%	0.1	-4.9	-97.3%	0.1	-5.0	-99.0%
Personal Income[3]	$128,362	$3,008	-$125,354	-97.7%	$3,008	-$125,354	-97.7%	$1,150	-$127,212	-99.1%
Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state										
Employment[2]	6.3	0.4	-5.9	-93.7%	0.4	-5.9	-93.7%	0.1	-6.2	-99.0%
Personal Income[3]	$159,926	$10,032	-$149,894	-93.7%	$10,032	-$149,894	-93.7%	$1,568	-$158,357	-99.0%
State:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	1,203.5	2.8	-1,200.7	-99.8%	2.8	-1,200.7	-99.8%	0.0	-1,203.5	-100.0%
Employment[2]	71.0	0.1	-70.9	-99.8%	0.1	-70.9	-99.8%	0.0	-71.0	-100.0%
esidents of Washington.	$1,807,511	$3,167	-$1,804,344	-99.8%	$3,167	-$1,804,344	-99.8%	$0	-$1,807,511	-100.0%
Tribal:										
Jobs[1]	2,629.8	588.9	-2,040.9	-77.6%	480.4	-2,149.4	-81.7%	54.2	-2,575.5	-97.9%
Employment[2]	107.8	27.2	-80.6	-74.8%	19.8	-88.0	-81.6%	1.3	-106.5	-98.8%
Personal Income[3]	$2,740,275	$617,253	-$2,123,022	-77.5%	$450,798	-$2,289,477	-83.5%	$30,700	-$2,709,575	-98.9%
Processing Sector:										
Employment[2]	280.9	47.5	-233.4	-83.1%	38.6	-242.3	-86.3%	5.9	-274.9	-97.9%
Personal Income[3]	$7,137,841	$1,207,994	-$5,929,847	-83.1%	$981,271	-$6,156,570	-86.3%	$151,154	-$6,986,687	-97.9%

Note: Regional totals may not sum up to statewide totals because of differences in regional and statewide employment and personal income coefficients generated by the FEAM model.

[1] Represents full- and part-time jobs.

[2] Represents full-time equivalent jobs.

[3] Personal income, expressed in 2002 dollars, includes employee compensation, proprietor income, and other property income.

Table 4.6-4. Impacts to sport fishing trips and expenditures by region.
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Marine trips originating from the region[1]	125,372	-125,372	-100.0%	-125,372	-100.0%	-125,372	-100.0%
Freshwater trips occurring in the region[2]	371,857	-251,911	-67.7%	-300,883	-80.9%	-369,806	-99.4%
Total trips	497,229	-377,283	-75.9%	-426,255	-85.7%	-495,178	-99.6%
Expenditures in the region[3]	$31,974,199	-$6,208,411	-19.4%	-$7,114,001	-22.2%	-$8,388,511	-26.2%
South Puget Sound/South Hood Canal:							
Marine trips originating from the region[1]	238,655	-238,655	-100.0%	-238,655	-100.0%	-238,655	-100.0%
Freshwater trips occurring in the region[2]	288,616	-185,801	-64.4%	-185,799	-64.4%	-286,497	-99.3%
Total trips	527,271	-424,456	-80.5%	-424,454	-80.5%	-525,152	-99.6%
Expenditures in the region[3]	$33,074,640	-$3,740,707	-11.3%	-$3,740,642	-11.3%	-$4,736,183	-14.3%
Strait of Juan de Fuca/North Hood Canal:							
Marine trips originating from the region[1]	359,534	-359,534	-100.0%	-359,534	-100.0%	-359,534	-100.0%
Freshwater trips occurring in the region[2]	58,578	-49,398	-84.3%	-54,840	-93.6%	-58,438	-99.8%
Total trips	418,112	-408,932	-97.8%	-414,374	-99.1%	-417,972	-100.0%
Expenditures in the region[3]	$24,456,744	-$16,765,658	-68.6%	-$16,973,950	-69.4%	-$17,111,689	-70.0%
Regional Total:							
Marine trips originating from the region[1]	723,561	-723,561	-100.0%	-723,561	-100.0%	-723,561	-100.0%
Freshwater trips occurring in the region[2]	719,051	-487,110	-67.7%	-541,522	-75.3%	-714,741	-99.4%
Total trips	1,442,612	-1,210,671	-83.9%	-1,265,083	-87.7%	-1,438,302	-99.7%
Expenditures in the region[3]	$89,505,583	-$26,714,777	-29.8%	-$27,828,594	-31.1%	-$30,236,383	-33.8%

Note: Detailed information for angler types in included in the Economics Technical Appendix (Appendix D).

[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch are: originating from a marina or launch area in the region identified.

[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identifiec

[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed tha because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

Table 4.6-5. Regional economic impacts of the alternatives.
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Commercial Fishing Effects							
Sales[1]	$17,323,358	-$16,566,533	-95.6%	-$17,303,770	-99.9%	-$17,309,094	-99.9%
Employment[2]	522.5	-495.8	-94.9%	-521.9	-99.9%	-522.1	-99.9%
Personal Income[3]	$16,727,041	-$15,874,356	-94.9%	-$16,709,879	-99.9%	-$16,714,413	-99.9%
Sport Fishing Effects							
Sales[4]	$31,974,199	-$6,208,411	-19.4%	-$7,114,001	-22.2%	-$8,388,511	-26.2%
Employment[2]	567.7	-118.2	-20.8%	-135.2	-23.8%	-159.0	-28.0%
Personal Income[3]	$21,520,877	-$4,216,375	-19.6%	-$4,835,613	-22.5%	-$5,707,116	-26.5%
South Puget Sound/South Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$8,988,798	-$5,414,725	-60.2%	-$5,414,725	-60.2%	-$8,573,387	-95.4%
Employment[2]	223.1	-134.9	-60.4%	-134.9	-60.4%	-212.3	-95.1%
Personal Income[3]	$8,061,452	-$4,870,679	-60.4%	-$4,870,679	-60.4%	-$7,669,101	-95.1%
Sport Fishing Effects							
Sales[4]	$33,074,640	-$3,740,707	-11.3%	-$3,740,642	-11.3%	-$4,736,183	-14.3%
Employment[2]	518.5	-65.0	-12.5%	-65.0	-12.5%	-81.7	-15.8%
Personal Income[3]	$24,679,752	-$2,819,364	-11.4%	-$2,819,314	-11.4%	-$3,578,165	-14.5%
Strait of Juan de Fuca/North Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$811,156	-$770,014	-94.9%	-$770,014	-94.9%	-$802,748	-99.0%
Employment[2]	19.2	-18.2	-94.6%	-18.2	-94.6%	-19.0	-99.1%
Personal Income[3]	$567,455	-$536,783	-94.6%	-$536,783	-94.6%	-$562,146	-99.1%
Sport Fishing Effects							
Sales[4]	$24,456,744	-$16,765,658	-68.6%	-$16,973,950	-69.4%	-$17,111,689	-70.0%
g from a marina or launch are	500.5	-355.1	-70.9%	-359.2	-71.8%	-361.8	-72.3%
Personal Income[3]	$14,563,148	-$9,931,028	-68.2%	-$10,057,788	-69.1%	-$10,141,612	-69.6%
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified							
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed tha							
Sales[1]	$27,123,312	-$22,751,272	-83.9%	-$23,488,509	-86.6%	-$26,685,228	-98.4%
Employment[2]	748.6	-631.4	-84.4%	-656.7	-87.7%	-737.0	-98.5%
Personal Income[3]	$26,023,282	-$21,953,163	-84.4%	-$22,828,837	-87.7%	-$25,620,136	-98.5%
Sport Fishing Effects[5]							
Sales[4]	$90,085,979	-$5,218,618	-5.8%	-$5,355,919	-5.9%	-$5,743,798	-6.4%
Employment[2]	1,569.5	-97.1	-6.2%	-99.8	-6.4%	-107.5	-6.8%
Personal Income[3]	$68,627,051	-$3,947,656	-5.8%	-$4,055,622	-5.9%	-$4,360,625	-6.4%

Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

[1] Represents direct commercial salmon harvester and processing sales in 2002 dollars.
[2] Represents total (direct and secondary) full-time equivalent jobs.
[3] Represents total (direct and secondary) personal income in 2002 dollars. Personal income includes employee compensation, proprietor income, and other property income.
[4] Represents direct sales to sport fishing anglers in 2002 dollars.
[5] Under alternatives to the Proposed Action, statewide effects for sportfishing include only those generated by changes in spending by non-residents of Washington.

Table 4.6-6. Impacts to commercial harvest, commercial harvest value, and processing value.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
	Proposed Action/ Status Quo	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North:										
Non-Tribal										
Harvest (pounds)	5,533,374	3,032	-5,530,343	-99.9%	3,032	-5,530,343	-99.9%	0	-5,533,374	-100.0%
Harvest Value	$2,637,498	$1,434	-$2,636,064	-99.9%	$1,434	-$2,636,064	-99.9%	$0	-$2,637,498	-100.0%
Tribal										
Harvest (pounds)	6,691,701	640,844	-6,050,857	-90.4%	14,081	-6,677,620	-99.8%	13,310	-6,678,390	-99.8%
Harvest Value	$3,109,566	$216,272	-$2,893,294	-93.0%	$4,189	-$3,105,377	-99.9%	$3,873	-$3,105,693	-99.9%
Processing Value	$11,452,379	$534,735	-$10,917,644	-95.3%	$13,965	-$11,438,414	-99.9%	$10,389	-$11,441,990	-99.9%
South Puget Sound/South Hood Canal:										
Non-Tribal										
Harvest (pounds)	2,516,170	0	-2,516,170	-100.0%	0	-2,516,170	-100.0%	0	-2,516,170	-100.0%
Harvest Value	$627,257	$0	-$627,257	-100.0%	$0	-$627,257	-100.0%	$0	-$627,257	-100.0%
Tribal										
Harvest (pounds)	4,762,847	2,685,646	-2,077,200	-43.6%	2,685,646	-2,077,200	-43.6%	411,384	-4,351,463	-91.4%
Harvest Value	$1,730,353	$914,493	-$815,860	-47.1%	$914,493	-$815,860	-47.1%	$100,262	-$1,630,091	-94.2%
Processing Value	$6,546,846	$2,590,409	-$3,956,437	-60.4%	$2,590,409	-$3,956,437	-60.4%	$315,142	-$6,231,703	-95.2%
Strait of Juan de Fuca/North Hood Canal:										
Non-Tribal										
Harvest (pounds)	10,920	13,340	2,420	22.2%	13,340	2,420	22.2%	0	-10,920	-100.0%
Harvest Value	$5,132	$6,270	$1,138	22.2%	$6,270	$1,138	22.2%	$0	-$5,132	-100.0%
Tribal										
Harvest (pounds)	420,792	13,559	-407,232	-96.8%	13,559	-407,232	-96.8%	4,255	-416,537	-99.0%
Harvest Value	$292,912	$6,658	-$286,254	-97.7%	$6,658	-$286,254	-97.7%	$2,841	-$290,071	-99.0%
Processing Value	$513,111	$28,214	-$484,897	-94.5%	$28,214	-$484,897	-94.5%	$5,567	-$507,544	-98.9%
Statewide Total:										
[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area										
Harvest (pounds)	8,060,464	16,372	-8,044,092	-99.8%	16,372	-8,044,092	-99.8%	0	-8,060,464	-100.0%
thin the region identified	$3,269,887	$7,704	-$3,262,183	-99.8%	$7,704	-$3,262,183	-99.8%	$0	-$3,269,887	-100.0%
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that										
Harvest (pounds)	11,875,339	3,340,050	-8,535,289	-71.9%	2,713,287	-9,162,052	-77.2%	428,949	-11,446,390	-96.4%
Harvest Value	$5,132,831	$1,137,423	-$3,995,408	-77.8%	$925,340	-$4,207,491	-82.0%	$106,976	-$5,025,855	-97.9%
Processing Value	$18,512,335	$3,153,358	-$15,358,978	-83.0%	$2,632,588	-$15,879,747	-85.8%	$331,098	-$18,181,237	-98.2%

Note: All dollar values are expressed in 2002 dollars.

Table 4.6-7. Direct economic impacts to the commercial fishing and salmon processing industries.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level Number	Alternative 2 Change from Alternative 1	Alternative 2 Percent Change	Alternative 3 - Escapement Goal Management at the Population Level Number	Alternative 3 Change from Alternative 1	Alternative 3 Percent Change	Alternative 4 - No Fishing Number	Alternative 4 Change from Alternative 1	Alternative 4 Percent Change
Puget Sound North										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	962.7	0.5	-962.2	-99.9%	0.5	-962.2	-99.9%	0.0	-962.7	-100.0%
Employment[2]	66.6	0.0	-66.6	-100.0%	0.0	-66.6	-100.0%	0.0	-66.6	-100.0%
Personal Income[3]	$1,710,634	$648	-$1,709,985	-100.0%	$648	-$1,709,985	-100.0%	$0	-$1,710,634	-100.0%
Tribal:										
Jobs[1]	1,576.6	109.6	-1,466.9	-93.0%	2.1	-1,574.4	-99.9%	2.0	-1,574.6	-99.9%
Employment[2]	75.5	7.8	-67.8	-89.7%	0.1	-75.5	-99.9%	0.1	-75.5	-99.9%
Personal Income[3]	$1,940,557	$178,276	-$1,762,282	-90.8%	$1,467	-$1,939,091	-99.9%	$1,303	-$1,939,254	-99.9%
Processing Sector:										
Employment[2]	180.5	9.5	-171.0	-94.7%	0.3	-180.3	-99.9%	0.2	-180.3	-99.9%
Personal Income[3]	$4,543,906	$240,408	-$4,303,498	-94.7%	$6,365	-$4,537,541	-99.9%	$4,922	-$4,538,985	-99.9%
South Puget Sound/South Hood Canal:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	228.9	0.0	-228.9	-100.0%	0.0	-228.9	-100.0%	0.0	-228.9	-100.0%
Employment[2]	7.4	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%
Personal Income[3]	$185,657	$0	-$185,657	-100.0%	$0	-$185,657	-100.0%	$0	-$185,657	-100.0%
Tribal:										
Jobs[1]	877.3	463.6	-413.6	-47.1%	463.6	-413.6	-47.1%	50.8	-826.5	-94.2%
Employment[2]	29.6	18.8	-10.9	-36.7%	18.8	-10.9	-36.7%	1.3	-28.4	-95.7%
Personal Income[3]	$745,461	$419,688	-$325,774	-43.7%	$419,688	-$325,774	-43.7%	$28,288	-$717,174	-96.2%
Processing Sector:										
Employment[2]	93.9	34.7	-59.2	-63.1%	34.7	-59.2	-63.1%	5.3	-88.6	-94.4%
from a marina or launch a	$2,427,658	$896,824	-$1,530,834	-63.1%	$896,824	-$1,530,834	-63.1%	$136,497	-$2,291,161	-94.4%
Strait of Juan de Fuca/North Hood Canal:										
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.										
g because it is assumed t										
Jobs[1]	1.9	2.3	0.4	22.2%	2.3	0.4	22.2%	0.0	-1.9	-100.0%
Employment[2]	0.1	0.1	0.0	37.9%	0.1	0.0	37.9%	0.0	-0.1	-100.0%
Personal Income[3]	$2,180	$2,664	$483	22.2%	$2,664	$483	22.2%	$0	-$2,180	-100.0%
Tribal:										
Jobs[1]	148.5	3.4	-145.1	-97.7%	3.4	-145.1	-97.7%	1.4	-147.1	-99.0%
Employment[2]	5.0	0.1	-4.9	-97.3%	0.1	-4.9	-97.3%	0.1	-5.0	-99.0%
Personal Income[3]	$128,362	$3,008	-$125,353	-97.7%	$3,008	-$125,353	-97.7%	$1,150	-$127,212	-99.1%
Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state										
Employment[2]	6.3	0.4	-5.9	-93.7%	0.4	-5.9	-93.7%	0.1	-6.2	-99.0%
Personal Income[3]	$159,926	$10,032	-$149,894	-93.7%	$10,032	-$149,894	-93.7%	$1,568	-$158,357	-99.0%
State:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	1,193.5	2.8	-1,190.7	-99.8%	2.8	-1,190.7	-99.8%	0.0	-1,193.5	-100.0%
Employment[2]	70.5	0.1	-70.4	-99.8%	0.1	-70.4	-99.8%	0.0	-70.5	-100.0%
on-residents of Washingto	$1,793,789	$3,167	-$1,790,623	-99.8%	$3,167	-$1,790,623	-99.8%	$0	-$1,793,789	-100.0%
Tribal:										
Jobs[1]	2,602.3	576.7	-2,025.7	-77.8%	469.1	-2,133.2	-82.0%	54.2	-2,548.1	-97.9%
Employment[2]	106.6	26.5	-80.0	-75.1%	19.2	-87.4	-82.0%	1.3	-105.3	-98.8%
Personal Income[3]	$2,709,241	$602,090	-$2,107,151	-77.8%	$436,609	-$2,272,632	-83.9%	$30,698	-$2,678,543	-98.9%
Processing Sector:										
Employment[2]	279.3	47.0	-232.3	-83.2%	38.1	-241.2	-86.4%	5.9	-273.4	-97.9%
Personal Income[3]	$7,098,058	$1,194,516	-$5,903,543	-83.2%	$968,659	-$6,129,400	-86.4%	$151,152	-$6,946,907	-97.9%

Note: Regional totals may not sum up to statewide totals because of differences in regional and statewide employment and personal income coefficients generated by the FEAM model

[1] Represents full- and part-time jobs.

[2] Represents full-time equivalent jobs.

[3] Personal income, expressed in 2002 dollars, includes employee compensation, proprietor income, and other property income.

Table 4.6-8. Impacts to sport fishing trips and expenditures by region.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Marine trips originating from the region[1]	125,121	-125,121	-100.0%	-125,121	-100.0%	-125,121	-100.0%
Freshwater trips occurring in the region[2]	371,435	-258,296	-69.5%	-307,335	-82.7%	-369,384	-99.4%
Total trips	496,556	-383,417	-77.2%	-432,456	-87.1%	-494,505	-99.6%
Expenditures in the region[3]	$31,931,283	-$6,323,085	-19.8%	-$7,229,930	-22.6%	-$8,377,306	-26.2%
South Puget Sound/South Hood Canal:							
Marine trips originating from the region[1]	234,995	-234,995	-100.0%	-234,995	-100.0%	-234,995	-100.0%
Freshwater trips occurring in the region[2]	284,800	-183,525	-64.4%	-183,523	-64.4%	-282,681	-99.3%
Total trips	519,795	-418,520	-80.5%	-418,518	-80.5%	-517,676	-99.6%
Expenditures in the region[3]	$32,607,684	-$3,686,620	-11.3%	-$3,686,620	-11.3%	-$4,666,871	-14.3%
Strait of Juan de Fuca/North Hood Canal:							
Marine trips originating from the region[1]	359,259	-359,259	-100.0%	-359,259	-100.0%	-359,259	-100.0%
Freshwater trips occurring in the region[2]	58,492	-49,425	-84.5%	-54,874	-93.8%	-58,352	-99.8%
Total trips	417,751	-408,684	-97.8%	-414,133	-99.1%	-417,611	-100.0%
Expenditures in the region[3]	$24,435,112	-$16,757,867	-68.6%	-$16,966,489	-69.4%	-$17,099,608	-70.0%
Regional Total:							
Marine trips originating from the region[1]	719,375	-719,375	-100.0%	-719,375	-100.0%	-719,375	-100.0%
Freshwater trips occurring in the region[2]	714,727	-491,246	-68.7%	-545,732	-76.4%	-710,417	-99.4%
Total trips	1,434,102	-1,210,621	-84.4%	-1,265,107	-88.2%	-1,429,792	-99.7%
Expenditures in the region[3]	$88,974,079	-$26,767,573	-30.1%	-$27,883,039	-31.3%	-$30,143,785	-33.9%

Note: Detailed information for angler types in included in the Economics Technical Appendix (Appendix D).

[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch are
or launch area in the region identified.

[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identifiec

[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed tha
that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

Table 4.6-9. Regional economic impacts of the alternatives.
Scenario B: 2003 Abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Change from Alternative 1	Alternative 4: Percent Change
North Puget Sound:							
Commercial Fishing Effects							
Sales[1]	$17,199,443	-$16,447,002	-95.6%	-$17,179,855	-99.9%	-$17,185,181	-99.9%
Employment[2]	519.0	-492.5	-94.9%	-518.5	-99.9%	-518.6	-99.9%
Personal Income[3]	$16,616,225	-$15,767,469	-94.9%	-$16,599,062	-99.9%	-$16,603,598	-99.9%
Sport Fishing Effects							
Sales[4]	$31,931,283	-$6,323,085	-19.8%	-$7,229,930	-22.6%	-$8,377,306	-26.2%
Employment[2]	567.0	-120.3	-21.2%	-137.3	-24.2%	-158.8	-28.0%
Personal Income[3]	$21,492,002	-$4,294,853	-20.0%	-$4,914,949	-22.9%	-$5,699,519	-26.5%
South Puget Sound/South Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$8,904,456	-$5,399,554	-60.6%	-$5,399,554	-60.6%	-$8,489,051	-95.3%
Employment[2]	221.1	-134.5	-60.8%	-134.5	-60.8%	-210.3	-95.1%
Personal Income[3]	$7,987,892	-$4,857,512	-60.8%	-$4,857,512	-60.8%	-$7,595,547	-95.1%
Sport Fishing Effects							
Sales[4]	$32,607,684	-$3,686,620	-11.3%	-$3,686,620	-11.3%	-$4,666,871	-14.3%
Employment[2]	511.2	-64.1	-12.5%	-64.1	-12.5%	-80.5	-15.8%
Personal Income[3]	$24,331,289	-$2,778,665	-11.4%	-$2,778,665	-11.4%	-$3,525,860	-14.5%
Strait of Juan de Fuca/North Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$811,155	-$770,013	-94.9%	-$770,013	-94.9%	-$802,747	-99.0%
Employment[2]	19.2	-18.2	-94.6%	-18.2	-94.6%	-19.0	-99.1%
Personal Income[3]	$567,454	-$536,782	-94.6%	-$536,782	-94.6%	-$562,145	-99.1%
Sport Fishing Effects							
Sales[4]	$24,435,112	-$16,757,867	-68.6%	-$16,966,489	-69.4%	-$17,099,608	-70.0%
from a marina or launch area	500.1	-354.9	-71.0%	-359.0	-71.8%	-361.6	-72.3%
Personal Income[3]	$14,550,212	-$9,926,446	-68.2%	-$10,053,407	-69.1%	-$10,134,420	-69.7%
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.							
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assume							
Sales[1]	$26,915,053	-$22,616,569	-84.0%	-$23,349,422	-86.8%	-$26,476,979	-98.4%
Employment[2]	743.1	-627.9	-84.5%	-653.0	-87.9%	-731.6	-98.4%
Personal Income[3]	$25,835,001	-$21,828,671	-84.5%	-$22,700,247	-87.9%	-$25,431,863	-98.4%
Sport Fishing Effects[5]							
Sales[4]	$89,552,061	-$5,213,429	-5.8%	-$5,351,019	-6.0%	-$5,719,922	-6.4%
Employment[2]	1,560.4	-97.0	-6.2%	-99.7	-6.4%	-107.0	-6.9%
Personal Income[3]	$68,220,788	-$3,944,122	-5.8%	-$4,052,314	-5.9%	-$4,342,396	-6.4%

Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

[1] Represents direct commercial salmon harvester and processing sales in 2002 dollars.

[2] Represents total (direct and secondary) full-time equivalent jobs.

[3] Represents total (direct and secondary) personal income in 2002 dollars. Personal income includes employee compensation, proprietor income, and other property income.

[4] Represents direct sales to sport fishing anglers in 2002 dollars.

[5] Under alternatives to the Proposed Action, statewide effects for sportfishing include only those generated by changes in spending by non-residents of Washington. Changes in spending by Washington residents would merely redirect money already in the state economy and would result in no net economic effects.

Table 4.6-10. Impacts to commercial harvest, commercial harvest value, and processing value.
Scenario C: 30% Reduction in abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North:										
Non-Tribal										
Harvest (pounds)	5,474,785	0	-5,474,785	-100.0%	0	-5,474,785	-100.0%	0	-5,474,785	-100.0%
Harvest Value	$2,589,993	$0	-$2,589,993	-100.0%	$0	-$2,589,993	-100.0%	$0	-$2,589,993	-100.0%
Tribal										
Harvest (pounds)	6,604,161	370,510	-6,233,651	-94.4%	14,081	-6,590,080	-99.8%	13,310	-6,590,850	-99.8%
Harvest Value	$3,039,344	$64,176	-$2,975,169	-97.9%	$4,189	-$3,035,156	-99.9%	$3,873	-$3,035,472	-99.9%
Processing Value	$11,303,131	$269,359	-$11,033,773	-97.6%	$11,113	-$11,292,018	-99.9%	$10,389	-$11,292,742	-99.9%
South Puget Sound/South Hood Canal:										
Non-Tribal										
Harvest (pounds)	2,516,383	0	-2,516,383	-100.0%	0	-2,516,383	-100.0%	0	-2,516,383	-100.0%
Harvest Value	$627,357	$0	-$627,357	-100.0%	$0	-$627,357	-100.0%	$0	-$627,357	-100.0%
Tribal										
Harvest (pounds)	4,605,362	2,458,337	-2,147,025	-46.6%	2,458,337	-2,147,025	-46.6%	411,384	-4,193,979	-91.1%
Harvest Value	$1,629,120	$771,288	-$857,831	-52.7%	$771,288	-$857,831	-52.7%	$100,262	-$1,528,858	-93.8%
Processing Value	$6,334,627	$2,285,814	-$4,048,813	-63.9%	$2,285,814	-$4,048,813	-63.9%	$315,142	-$6,019,485	-95.0%
Strait of Juan de Fuca/North Hood Canal:										
Non-Tribal										
Harvest (pounds)	10,932	13,340	2,409	22.0%	13,340	2,409	22.0%	0	-10,932	-100.0%
Harvest Value	$5,138	$6,270	$1,132	22.0%	$6,270	$1,132	22.0%	$0	-$5,138	-100.0%
Tribal										
Harvest (pounds)	420,806	13,559	-407,247	-96.8%	13,559	-407,247	-96.8%	4,255	-416,551	-99.0%
Harvest Value	$292,918	$6,658	-$286,260	-97.7%	$6,658	-$286,260	-97.7%	$2,841	-$290,077	-99.0%
Processing Value	$513,136	$28,214	-$484,922	-94.5%	$28,214	-$484,922	-94.5%	$5,567	-$507,569	-98.9%
Statewide Total:										
[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area										
Harvest (pounds)	8,002,099	13,340	-7,988,759	-99.8%	13,340	-7,988,759	-99.8%	0	-8,002,099	-100.0%
thin the region identified	$3,222,488	$6,270	-$3,216,218	-99.8%	$6,270	-$3,216,218	-99.8%	$0	-$3,222,488	-100.0%
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that										
Harvest (pounds)	11,630,329	2,842,406	-8,787,923	-75.6%	2,485,978	-9,144,351	-78.6%	428,949	-11,201,380	-96.3%
Harvest Value	$4,961,382	$842,122	-$4,119,260	-83.0%	$782,135	-$4,179,247	-84.2%	$106,976	-$4,854,406	-97.8%
Processing Value	$18,150,894	$2,583,387	-$15,567,508	-85.8%	$2,325,142	-$15,825,753	-87.2%	$331,098	-$17,819,796	-98.2%

Note: All dollar values are expressed in 2002 dollars.

Table 4.6-11. Direct economic impacts to the commercial fishing and salmon processing industries.
Scenario C: 30% Reduction in abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	945.3	0.0	-945.3	-100.0%	0.0	-945.3	-100.0%	0.0	-945.3	-100.0%
Employment[2]	65.6	0.0	-65.6	-100.0%	0.0	-65.6	-100.0%	0.0	-65.6	-100.0%
Personal Income[3]	$1,685,474	$0	-$1,685,474	-100.0%	$0	-$1,685,474	-100.0%	$0	-$1,685,474	-100.0%
Tribal:										
Jobs[1]	1,540.9	32.5	-1,508.4	-97.9%	2.1	-1,538.8	-99.9%	2.0	-1,539.0	-99.9%
Employment[2]	74.1	4.3	-69.8	-94.2%	0.1	-74.0	-99.9%	0.1	-74.0	-99.9%
Personal Income[3]	$1,902,511	$98,163	-$1,804,348	-94.8%	$1,467	-$1,901,044	-99.9%	$1,303	-$1,901,207	-99.9%
Processing Sector:										
Employment[2]	178.4	5.5	-172.9	-96.9%	0.2	-178.1	-99.9%	0.2	-178.2	-99.9%
Personal Income[3]	$4,489,166	$137,154	-$4,352,012	-96.9%	$5,214	-$4,483,952	-99.9%	$4,922	-$4,484,245	-99.9%
South Puget Sound/South Hood Canal:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	229.0	0.0	-229.0	-100.0%	0.0	-229.0	-100.0%	0.0	-229.0	-100.0%
Employment[2]	7.4	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%
Personal Income[3]	$185,698	$0	-$185,698	-100.0%	$0	-$185,698	-100.0%	$0	-$185,698	-100.0%
Tribal:										
Jobs[1]	826.0	391.0	-434.9	-52.7%	391.0	-434.9	-52.7%	50.8	-775.1	-93.8%
Employment[2]	27.2	14.9	-12.3	-45.3%	14.9	-12.3	-45.3%	1.3	-25.9	-95.3%
Personal Income[3]	$683,033	$331,855	-$351,178	-51.4%	$331,855	-$351,178	-51.4%	$28,288	-$654,745	-95.9%
Processing Sector:										
Employment[2]	91.8	31.7	-60.1	-65.5%	31.7	-60.1	-65.5%	5.3	-86.5	-94.2%
rom a marina or launch a	$2,374,849	$820,448	-$1,554,401	-65.5%	$820,448	-$1,554,401	-65.5%	$136,497	-$2,238,352	-94.3%
Strait of Juan de Fuca/North Hood Canal:										
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.										
g because it is assumed t										
Jobs[1]	1.9	2.3	0.4	22.0%	2.3	0.4	22.0%	0.0	-1.9	-100.0%
Employment[2]	0.1	0.1	0.0	37.8%	0.1	0.0	37.8%	0.0	-0.1	-100.0%
Personal Income[3]	$2,183	$2,664	$481	22.0%	$2,664	$481	22.0%	$0	-$2,183	-100.0%
Tribal:										
Jobs[1]	148.5	3.4	-145.1	-97.7%	3.4	-145.1	-97.7%	1.4	-147.1	-99.0%
Employment[2]	5.0	0.1	-4.9	-97.3%	0.1	-4.9	-97.3%	0.1	-5.0	-99.0%
Personal Income[3]	$128,364	$3,008	-$125,356	-97.7%	$3,008	-$125,356	-97.7%	$1,150	-$127,214	-99.1%
Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state										
Employment[2]	6.3	0.4	-5.9	-93.7%	0.4	-5.9	-93.7%	0.1	-6.2	-99.0%
Personal Income[3]	$159,935	$10,032	-$149,903	-93.7%	$10,032	-$149,903	-93.7%	$1,568	-$158,367	-99.0%
State:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	1,176.2	2.3	-1,173.9	-99.8%	2.3	-1,173.9	-99.8%	0.0	-1,176.2	-100.0%
Employment[2]	69.6	0.1	-69.5	-99.8%	0.1	-69.5	-99.8%	0.0	-69.6	-100.0%
on-residents of Washingt	$1,770,127	$2,576	-$1,767,552	-99.9%	$2,576	-$1,767,552	-99.9%	$0	-$1,770,127	-100.0%
Tribal:										
Jobs[1]	2,515.4	427.0	-2,088.5	-83.0%	396.5	-2,118.9	-84.2%	54.2	-2,461.2	-97.8%
Employment[2]	102.6	19.2	-83.4	-81.3%	15.1	-87.5	-85.3%	1.3	-101.3	-98.7%
Personal Income[3]	$2,608,057	$435,855	-$2,172,202	-83.3%	$344,754	-$2,263,304	-86.8%	$30,698	-$2,577,359	-98.8%
Processing Sector:										
Employment[2]	275.0	39.9	-235.1	-85.5%	34.8	-240.2	-87.3%	5.9	-269.1	-97.8%
Personal Income[3]	$6,989,134	$1,013,918	-$5,975,216	-85.5%	$885,907	-$6,103,227	-87.3%	$151,152	-$6,837,983	-97.8%

Note: Regional totals may not sum up to statewide totals because of differences in regional and statewide employment and personal income coefficients generated by the FEAM model

[1] Represents full- and part-time jobs.

[2] Represents full-time equivalent jobs.

[3] Personal income, expressed in 2002 dollars, includes employee compensation, proprietor income, and other property income.

Table 4.6-12. Impacts to sport fishing trips and expenditures by region.
Scenario C: 30% Reduction in abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level		Alternative 3 - Escapement Goal Management at the Population Level		Alternative 4 - No Fishing	
		Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change	Change from Alternative 1	Percent Change
North Puget Sound:							
Marine trips originating from the region[1]	118,554	-118,554	-100.0%	-118,554	-100.0%	-118,554	-100.0%
Freshwater trips occurring in the region[2]	351,609	-274,166	-78.0%	-300,306	-85.4%	-349,558	-99.4%
Total trips	470,163	-392,720	-83.5%	-418,860	-89.1%	-468,112	-99.6%
Expenditures in the region[3]	$30,233,716	-$6,535,617	-21.6%	-$7,018,991	-23.2%	-$7,929,732	-26.2%
South Puget Sound/South Hood Canal:							
Marine trips originating from the region[1]	215,562	-215,562	-100.0%	-215,562	-100.0%	-215,562	-100.0%
Freshwater trips occurring in the region[2]	263,094	-182,513	-69.4%	-182,513	-69.4%	-260,975	-99.2%
Total trips	478,656	-398,075	-83.2%	-398,075	-83.2%	-476,537	-99.6%
Expenditures in the region[3]	$30,032,910	-$3,514,752	-11.7%	-$3,514,752	-11.7%	-$4,290,425	-14.3%
Strait of Juan de Fuca/North Hood Canal:							
Marine trips originating from the region[1]	343,428	-343,428	-100.0%	-343,428	-100.0%	-343,428	-100.0%
Freshwater trips occurring in the region[2]	55,492	-49,941	-90.0%	-52,844	-95.2%	-55,352	-99.7%
Total trips	398,920	-393,369	-98.6%	-396,272	-99.3%	-398,780	-100.0%
Expenditures in the region[3]	$23,334,015	-$16,121,151	-69.1%	-$16,232,293	-69.6%	-$16,328,320	-70.0%
Regional Total:							
Marine trips originating from the region[1]	677,544	-677,544	-100.0%	-677,544	-100.0%	-677,544	-100.0%
Freshwater trips occurring in the region[2]	670,195	-506,620	-75.6%	-535,663	-79.9%	-665,885	-99.4%
Total trips	1,347,739	-1,184,164	-87.9%	-1,213,207	-90.0%	-1,343,429	-99.7%
Expenditures in the region[3]	$83,600,641	-$26,171,521	-31.3%	-$26,766,036	-32.0%	-$28,548,477	-34.1%

Note: Detailed information for angler types in included in the Economics Technical Appendix (Appendix D).

[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch are area in the region identified.

[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identifiec

[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed tha assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

Table 4.6-13. Regional economic impacts of the alternatives.

Scenario C: 30% Reduction in abundance and 2003 Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Change from Alternative 1	Alternative 4: Percent Change
North Puget Sound:							
Commercial Fishing Effects							
Sales[1]	$16,932,469	-$16,598,935	-98.0%	-$16,917,166	-99.9%	-$16,918,207	-99.9%
Employment[2]	511.5	-496.6	-97.1%	-511.1	-99.9%	-511.1	-99.9%
Personal Income[3]	$16,376,958	-$15,899,777	-97.1%	-$16,363,414	-99.9%	-$16,364,332	-99.9%
Sport Fishing Effects							
Sales[4]	$30,233,716	-$6,535,617	-21.6%	-$7,018,991	-23.2%	-$7,929,732	-26.2%
Employment[2]	536.8	-124.2	-23.1%	-133.3	-24.8%	-150.4	-28.0%
Personal Income[3]	$20,349,409	-$4,441,685	-21.8%	-$4,772,213	-23.5%	-$5,394,974	-26.5%
South Puget Sound/South Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$8,591,104	-$5,534,001	-64.4%	-$5,534,001	-64.4%	-$8,175,700	-95.2%
Employment[2]	213.5	-137.7	-64.5%	-137.7	-64.5%	-202.7	-94.9%
Personal Income[3]	$7,713,533	-$4,974,125	-64.5%	-$4,974,125	-64.5%	-$7,321,188	-94.9%
Sport Fishing Effects							
Sales[4]	$30,032,910	-$3,514,752	-11.7%	-$3,514,752	-11.7%	-$4,290,425	-14.3%
Employment[2]	470.7	-61.0	-13.0%	-61.0	-13.0%	-74.0	-15.7%
Personal Income[3]	$22,409,940	-$2,650,376	-11.8%	-$2,650,376	-11.8%	-$3,241,632	-14.5%
Strait of Juan de Fuca/North Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$811,192	-$770,050	-94.9%	-$770,050	-94.9%	-$802,784	-99.0%
Employment[2]	19.2	-18.2	-94.6%	-18.2	-94.6%	-19.0	-99.1%
Personal Income[3]	$567,483	-$536,810	-94.6%	-$536,810	-94.6%	-$562,173	-99.1%
Sport Fishing Effects							
Sales[4]	$23,334,015	-$16,121,151	-69.1%	-$16,232,293	-69.6%	-$16,328,320	-70.0%
g from a marina or launch are	477.6	-341.3	-71.5%	-343.4	-71.9%	-345.3	-72.3%
Personal Income[3]	$13,894,215	-$9,550,833	-68.7%	-$9,618,471	-69.2%	-$9,676,911	-69.6%
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified							
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed							
Sales[1]	$26,334,765	-$22,902,986	-87.0%	-$23,221,218	-88.2%	-$25,896,691	-98.3%
Employment[2]	728.2	-635.2	-87.2%	-649.2	-89.2%	-716.6	-98.4%
Personal Income[3]	$25,314,356	-$22,081,797	-87.2%	-$22,569,799	-89.2%	-$24,911,218	-98.4%
Sport Fishing Effects[5]							
Sales[4]	$84,147,737	-$5,049,946	-6.0%	-$5,123,251	-6.1%	-$5,414,087	-6.4%
Employment[2]	1,466.8	-94.1	-6.4%	-95.5	-6.5%	-101.3	-6.9%
Personal Income[3]	$64,104,502	-$3,823,344	-6.0%	-$3,880,986	-6.1%	-$4,109,682	-6.4%

Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

[1] Represents direct commercial salmon harvester and processing sales in 2002 dollars.

[2] Represents total (direct and secondary) full-time equivalent jobs.

[3] Represents total (direct and secondary) personal income in 2002 dollars. Personal income includes employee compensation, proprietor income, and other property income.

[4] Represents direct sales to sport fishing anglers in 2002 dollars.

[5] Under alternatives to the Proposed Action, statewide effects for sportfishing include only those generated by changes in spending by non-residents of Washington. Changes in spending by Washington residents would merely redirect money already in the state economy and would result in no net economic effects.

Table 4.6-14. Impacts to commercial harvest, commercial harvest value, and processing value.
Scenario D: 30% Reduction in abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level			Alternative 3 - Escapement Goal Management at the Population Level			Alternative 4 - No Fishing		
		Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change	Number	Change from Alternative 1	Percent Change
Puget Sound North:										
Non-Tribal										
Harvest (pounds)	5,446,432	0	-5,446,432	-100.0%	0	-5,446,432	-100.0%	0	-5,446,432	-100.0%
Harvest Value	$2,567,061	$0	-$2,567,061	-100.0%	$0	-$2,567,061	-100.0%	$0	-$2,567,061	-100.0%
Tribal										
Harvest (pounds)	6,574,849	370,212	-6,204,637	-94.4%	14,081	-6,560,768	-99.8%	13,310	-6,561,539	-99.8%
Harvest Value	$3,016,306	$63,988	-$2,952,318	-97.9%	$4,189	-$3,012,117	-99.9%	$3,873	-$3,012,433	-99.9%
Processing Value	$11,244,390	$269,055	-$10,975,335	-97.6%	$11,113	-$11,233,276	-99.9%	$10,389	-$11,234,001	-99.9%
South Puget Sound/South Hood Canal:										
Non-Tribal										
Harvest (pounds)	2,516,308	0	-2,516,308	-100.0%	0	-2,516,308	-100.0%	0	-2,516,308	-100.0%
Harvest Value	$627,322	$0	-$627,322	-100.0%	$0	-$627,322	-100.0%	$0	-$627,322	-100.0%
Tribal										
Harvest (pounds)	4,577,736	2,431,935	-2,145,801	-46.9%	2,431,935	-2,145,801	-46.9%	411,384	-4,166,352	-91.0%
Harvest Value	$1,612,233	$754,655	-$857,578	-53.2%	$754,655	-$857,578	-53.2%	$100,262	-$1,511,971	-93.8%
Processing Value	$6,298,089	$2,250,435	-$4,047,653	-64.3%	$2,250,435	-$4,047,653	-64.3%	$315,142	-$5,982,946	-95.0%
Strait of Juan de Fuca/North Hood Canal:										
Non-Tribal										
Harvest (pounds)	10,920	13,340	2,420	22.2%	13,340	2,420	22.2%	0	-10,920	-100.0%
Harvest Value	$5,132	$6,270	$1,138	22.2%	$6,270	$1,138	22.2%	$0	-$5,132	-100.0%
Tribal										
Harvest (pounds)	420,800	13,559	-407,241	-96.8%	13,559	-407,241	-96.8%	4,255	-416,545	-99.0%
Harvest Value	$292,915	$6,658	-$286,257	-97.7%	$6,658	-$286,257	-97.7%	$2,841	-$290,074	-99.0%
Processing Value	$513,118	$28,214	-$484,904	-94.5%	$28,214	-$484,904	-94.5%	$5,567	-$507,551	-98.9%
Statewide Total:										
[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area										
Harvest (pounds)	7,973,660	13,340	-7,960,319	-99.8%	13,340	-7,960,319	-99.8%	0	-7,973,660	-100.0%
thin the region identified.	$3,199,515	$6,270	-$3,193,245	-99.8%	$6,270	-$3,193,245	-99.8%	$0	-$3,199,515	-100.0%
[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that										
Harvest (pounds)	11,573,385	2,815,707	-8,757,679	-75.7%	2,459,576	-9,113,810	-78.7%	428,949	-11,144,437	-96.3%
Harvest Value	$4,921,455	$825,301	-$4,096,154	-83.2%	$765,502	-$4,155,953	-84.4%	$106,976	-$4,814,479	-97.8%
Processing Value	$18,055,597	$2,547,704	-$15,507,892	-85.9%	$2,289,763	-$15,765,834	-87.3%	$331,098	-$17,724,499	-98.2%

Note: All dollar values are expressed in 2002 dollars.

Table 4.6-15. Direct economic impacts to the commercial fishing and salmon processing industries.
Scenario D: 30% Reduction in abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Management Unit Level: Number	Alternative 2: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Number	Alternative 3: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Number	Alternative 4: Change from Alternative 1	Alternative 4: Percent Change
Puget Sound North										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	937.0	0.0	-937.0	-100.0%	0.0	-937.0	-100.0%	0.0	-937.0	-100.0%
Employment[2]	65.2	0.0	-65.2	-100.0%	0.0	-65.2	-100.0%	0.0	-65.2	-100.0%
Personal Income[3]	$1,673,335	$0	-$1,673,335	-100.0%	$0	-$1,673,335	-100.0%	$0	-$1,673,335	-100.0%
Tribal:										
Jobs[1]	1,529.3	32.4	-1,496.8	-97.9%	2.1	-1,527.1	-99.9%	2.0	-1,527.3	-99.9%
Employment[2]	73.6	4.3	-69.3	-94.2%	0.1	-73.5	-99.9%	0.1	-73.5	-99.9%
Personal Income[3]	$1,890,123	$98,035	-$1,792,088	-94.8%	$1,467	-$1,888,656	-99.9%	$1,303	-$1,888,819	-99.9%
Processing Sector:										
Employment[2]	177.5	5.4	-172.1	-96.9%	0.2	-177.3	-99.9%	0.2	-177.3	-99.9%
Personal Income[3]	$4,467,556	$137,042	-$4,330,514	-96.9%	$5,214	-$4,462,342	-99.9%	$4,922	-$4,462,634	-99.9%
South Puget Sound/South Hood Canal:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	229.0	0.0	-229.0	-100.0%	0.0	-229.0	-100.0%	0.0	-229.0	-100.0%
Employment[2]	7.4	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%	0.0	-7.4	-100.0%
Personal Income[3]	$185,683	$0	-$185,683	-100.0%	$0	-$185,683	-100.0%	$0	-$185,683	-100.0%
Tribal:										
Jobs[1]	817.4	382.6	-434.8	-53.2%	382.6	-434.8	-53.2%	50.8	-766.6	-93.8%
Employment[2]	26.8	14.4	-12.4	-46.2%	14.4	-12.4	-46.2%	1.3	-25.5	-95.2%
Personal Income[3]	$672,982	$321,654	-$351,328	-52.2%	$321,654	-$351,328	-52.2%	$28,288	-$644,694	-95.8%
Processing Sector:										
Employment[2]	91.5	31.4	-60.1	-65.7%	31.4	-60.1	-65.7%	5.3	-86.2	-94.2%
from a marina or launch a	$2,365,528	$811,577	-$1,553,951	-65.7%	$811,577	-$1,553,951	-65.7%	$136,497	-$2,229,031	-94.2%
Strait of Juan de Fuca/North Hood Canal:										
[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.										
g because it is assumed t										
Jobs[1]	1.9	2.3	0.4	22.2%	2.3	0.4	22.2%	0.0	-1.9	-100.0%
Employment[2]	0.1	0.1	0.0	37.9%	0.1	0.0	37.9%	0.0	-0.1	-100.0%
Personal Income[3]	$2,180	$2,664	$483	22.2%	$2,664	$483	22.2%	$0	-$2,180	-100.0%
Tribal:										
Jobs[1]	148.5	3.4	-145.1	-97.7%	3.4	-145.1	-97.7%	1.4	-147.1	-99.0%
Employment[2]	5.0	0.1	-4.9	-97.3%	0.1	-4.9	-97.3%	0.1	-5.0	-99.0%
Personal Income[3]	$128,363	$3,008	-$125,354	-97.7%	$3,008	-$125,354	-97.7%	$1,150	-$127,213	-99.1%
Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state										
Employment[2]	6.3	0.4	-5.9	-93.7%	0.4	-5.9	-93.7%	0.1	-6.2	-99.0%
Personal Income[3]	$159,929	$10,032	-$149,897	-93.7%	$10,032	-$149,897	-93.7%	$1,568	-$158,360	-99.0%
State:										
Harvesting Sector:										
Non-Tribal:										
Jobs[1]	1,167.8	2.3	-1,165.5	-99.8%	2.3	-1,165.5	-99.8%	0.0	-1,167.8	-100.0%
Employment[2]	69.1	0.1	-69.0	-99.8%	0.1	-69.0	-99.8%	0.0	-69.1	-100.0%
on-residents of Washingto	$1,758,674	$2,576	-$1,756,098	-99.9%	$2,576	-$1,756,098	-99.9%	$0	-$1,758,674	-100.0%
Tribal:										
Jobs[1]	2,495.2	418.4	-2,076.7	-83.2%	388.1	-2,107.1	-84.4%	54.2	-2,440.9	-97.8%
Employment[2]	101.7	18.7	-83.0	-81.6%	14.7	-87.1	-85.6%	1.3	-100.4	-98.7%
Personal Income[3]	$2,585,893	$425,066	-$2,160,827	-83.6%	$334,084	-$2,251,809	-87.1%	$30,698	-$2,555,194	-98.8%
Processing Sector:										
Employment[2]	273.8	39.5	-234.3	-85.6%	34.5	-239.3	-87.4%	5.9	-267.9	-97.8%
Personal Income[3]	$6,958,446	$1,004,327	-$5,954,118	-85.6%	$876,423	-$6,082,023	-87.4%	$151,152	-$6,807,294	-97.8%

Note: Regional totals may not sum up to statewide totals because of differences in regional and statewide employment and personal income coefficients generated by the FEAM model

[1] Represents full- and part-time jobs.

[2] Represents full-time equivalent jobs.

[3] Personal income, expressed in 2002 dollars, includes employee compensation, proprietor income, and other property income.

Table 4.6-16. Impacts to sport fishing trips and expenditures by region.
Scenario D: 30% Reduction in abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Change from Alternative 1	Alternative 4: Percent Change
North Puget Sound:							
Marine trips originating from the region[1]	119,653	-119,653	-100.0%	-119,653	-100.0%	-119,653	-100.0%
Freshwater trips occurring in the region[2]	354,535	-282,791	-79.8%	-308,851	-87.1%	-352,484	-99.4%
Total trips	474,188	-402,444	-84.9%	-428,504	-90.4%	-472,137	-99.6%
Expenditures in the region[3]	$30,491,871	-$6,709,000	-22.0%	-$7,190,855	-23.6%	-$7,997,710	-26.2%
South Puget Sound/South Hood Canal:							
Marine trips originating from the region[1]	217,544	-217,544	-100.0%	-217,544	-100.0%	-217,544	-100.0%
Freshwater trips occurring in the region[2]	267,415	-189,746	-71.0%	-189,746	-71.0%	-265,296	-99.2%
Total trips	484,959	-407,290	-84.0%	-407,290	-84.0%	-482,840	-99.6%
Expenditures in the region[3]	$30,434,487	-$3,594,729	-11.8%	-$3,594,729	-11.8%	-$4,341,599	-14.3%
Strait of Juan de Fuca/North Hood Canal:							
Marine trips originating from the region[1]	352,411	-352,411	-100.0%	-352,411	-100.0%	-352,411	-100.0%
Freshwater trips occurring in the region[2]	56,352	-50,990	-90.5%	-53,885	-95.6%	-56,212	-99.8%
Total trips	408,763	-403,401	-98.7%	-406,296	-99.4%	-408,623	-100.0%
Expenditures in the region[3]	$23,911,897	-$16,523,168	-69.1%	-$16,633,979	-69.6%	-$16,723,078	-69.9%
Regional Total:							
Marine trips originating from the region[1]	689,608	-689,608	-100.0%	-689,608	-100.0%	-689,608	-100.0%
Freshwater trips occurring in the region[2]	678,302	-523,527	-77.2%	-552,482	-81.5%	-673,992	-99.4%
Total trips	1,367,910	-1,213,135	-88.7%	-1,242,090	-90.8%	-1,363,600	-99.7%
Expenditures in the region[3]	$84,838,256	-$26,826,897	-31.6%	-$27,419,563	-32.3%	-$29,062,386	-34.3%

Note: Detailed information for angler types in included in the Economics Technical Appendix (Appendix D).

[1] Marine trips include all local resident, non-local resident, and non-resident of the state sport fishing in the marine waters of Puget Sound and originating from a marina or launch area in the region identified.

[2] Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified

[3] Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

Table 4.6-17. Regional economic impacts of the alternatives.
Scenario D: 30% Reduction in abundance with maximum Canadian/Alaskan Pacific Salmon Treaty fisheries.

Region	Alternative 1 Proposed Action/ Status Quo	Alternative 2 - Escapement Goal Management at the Unit Level: Change from Alternative 1	Alternative 2: Percent Change	Alternative 3 - Escapement Goal Management at the Population Level: Change from Alternative 1	Alternative 3: Percent Change	Alternative 4 - No Fishing: Change from Alternative 1	Alternative 4: Percent Change
North Puget Sound:							
Commercial Fishing Effects							
Sales[1]	$16,827,756	-$16,494,713	-98.0%	-$16,812,454	-99.9%	-$16,813,494	-99.9%
Employment[2]	508.6	-493.7	-97.1%	-508.2	-99.9%	-508.2	-99.9%
Personal Income[3]	$16,283,382	-$15,806,686	-97.1%	-$16,269,838	-99.9%	-$16,270,755	-99.9%
Sport Fishing Effects							
Sales[4]	$30,491,871	-$6,709,000	-22.0%	-$7,190,855	-23.6%	-$7,997,710	-26.2%
Employment[2]	541.4	-127.5	-23.5%	-136.5	-25.2%	-151.6	-28.0%
Personal Income[3]	$20,523,138	-$4,559,981	-22.2%	-$4,889,470	-23.8%	-$5,441,193	-26.5%
South Puget Sound/South Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$8,537,644	-$5,532,554	-64.8%	-$5,532,554	-64.8%	-$8,122,240	-95.1%
Employment[2]	212.3	-137.7	-64.9%	-137.7	-64.9%	-201.4	-94.9%
Personal Income[3]	$7,667,405	-$4,973,409	-64.9%	-$4,973,409	-64.9%	-$7,275,061	-94.9%
Sport Fishing Effects							
Sales[4]	$30,434,487	-$3,594,729	-11.8%	-$3,594,729	-11.8%	-$4,341,599	-14.3%
Employment[2]	477.0	-62.3	-13.1%	-62.3	-13.1%	-74.9	-15.7%
Personal Income[3]	$22,709,494	-$2,711,198	-11.9%	-$2,711,198	-11.9%	-$3,280,499	-14.4%
Strait of Juan de Fuca/North Hood Canal:							
Commercial Fishing Effects							
Sales[1]	$811,166	-$770,024	-94.9%	-$770,024	-94.9%	-$802,758	-99.0%
Employment[2]	19.2	-18.2	-94.6%	-18.2	-94.6%	-19.0	-99.1%
Personal Income[3]	$567,463	-$536,790	-94.6%	-$536,790	-94.6%	-$562,153	-99.1%
Sport Fishing Effects							
Sales[4]	$23,911,897	-$16,523,168	-69.1%	-$16,633,979	-69.6%	-$16,723,078	-69.9%
om a marina or launch area	489.5	-349.8	-71.5%	-351.9	-71.9%	-353.7	-72.3%
Personal Income[3]	$14,237,944	-$9,788,652	-68.8%	-$9,856,089	-69.2%	-$9,910,311	-69.6%

2 Freshwater trips include all local resident, non-local resident, and non-resident of the state sport fishing trips to fresh waters within the region identified.

3 Expenditure effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assun

Sales[1]	$26,176,566	-$22,797,291	-87.1%	-$23,115,032	-88.3%	-$25,738,492	-98.3%
Employment[2]	724.0	-632.3	-87.3%	-646.4	-89.3%	-712.5	-98.4%
Personal Income[3]	$25,171,134	-$21,983,966	-87.3%	-$22,471,461	-89.3%	-$24,767,996	-98.4%
Sport Fishing Effects[5]							
Sales[4]	$85,396,400	-$5,179,514	-6.1%	-$5,252,602	-6.2%	-$5,523,958	-6.5%
Employment[2]	1,488.8	-96.5	-6.5%	-97.9	-6.6%	-103.3	-6.9%
Personal Income[3]	$65,055,332	-$3,921,734	-6.0%	-$3,979,205	-6.1%	-$4,192,583	-6.4%

Note: Sport fishing-related effects of alternatives to the Proposed Action include those associated only with non-local resident and non-resident of the state spending because it is assumed that spending by local resident anglers would continue in the region regardless of changes in local resident sport fishing activity under the alternatives.

1 Represents direct commercial salmon harvester and processing sales in 2002 dollars.

2 Represents total (direct and secondary) full-time equivalent jobs.

3 Represents total (direct and secondary) personal income in 2002 dollars. Personal income includes employee compensation, proprietor income, and other property income.

4 Represents direct sales to sport fishing anglers in 2002 dollars.

5 Under alternatives to the Proposed Action, statewide effects for sportfishing include only those generated by changes in spending by non-residents of Washington. Changes in spending by Washington residents would merely redirect money already in the state economy and would result in no net economic effects.

Table 4.6-18. Baseline and change in net economic values of commercial salmon fishing (in millions of 2002 dollars).

Scenario	Baseline Conditions (Proposed Action/Status Quo)	Change from Baseline Conditions		
		Alternative 2: Management Unit Escapement Goal Management	Alternative 3: Population Unit Escapement Goal Management	Alternative 4: No Fishing
Scenario A: 2003 Abundance and 2003 Canadian/ Alaskan PST Fisheries	$8.4 M	-$9.7 M	-$10.0 M	-$11.2 M
Scenario B: 2003 Abundance and Maximum Canadian/ Alaskan PST Fisheries	$8.3 M	-$9.7 M	-$9.9 M	-$11.2 M
Scenario C: 30% Reduction in Abundance and 2003 Canadian/ Alaskan PST Fisheries	$8.2 M	-$9.8 M	-$9.9 M	-$10.9 M
Scenario D: 30% Reduction in Abundance and Maximum Canadian/ Alaskan PST Fisheries	$8.1 M	-$9.7 M	-$9.8 M	-$10.9 M

Note: The reductions in net economic values associated with Alternatives 2 through 4 are larger than baseline conditions because these values include the costs to society associated with unemployed labor resources and expected losses in capital investment value.

Table 4.6-19. Baseline and changes in angler days and net economic value (NEV) of salmon sport fishing in the Puget Sound area.

Scenario	Baseline Conditions (Proposed Action/ Status Quo)		Alternative 2: Management Unit Escapement Goal Management		Alternative 3: Population Unit Escapement Goal Management		Alternative 4: No Fishing	
	Angler Days	NEV	Change in Angler Days	Change in NEV	Change in Angler Days	Change in NEV	Change in Angler Days	Change in NEV
Scenario A: 2003 Abundance and 2003 Canadian/Alaskan PST Fisheries	1,443,600	$98.2 M	-1,211,660	-$82.4 M	-1,266,070	-$86.1 M	-1,439,290	-$97.9 M
Scenario B: 2003 Abundance and Maximum Canadian/ Alaskan PST Fisheries	1,434,100	$97.5 M	-1,210,620	-$82.3 M	-1,265,100	-$86.0 M	-1,429,790	-$97.2 M
Scenario C: 30% Reduction in Abundance and 2003 Canadian/ Alaskan PST Fisheries	1,347,700	$91.6 M	-1,184,120	-$80.5 M	-1,213,170	-$82.5 M	-1,363,590	-$92.7 M
Scenario D: 30% Reduction in Abundance and Maximum Canadian/ Alaskan PST Fisheries	1,367,900	$93.0 M	-1,212,920	-$82.5 M	-1,242,080	-$84.5 M	-1,363,590	-$92.7 M

Note: Monetary values are expressed in millions of 2002 dollars.

4.6.6 Cumulative Effects

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR1508.7). For the purposes of this discussion, the terms "effects" and "impacts" will be considered synonymously with "consequences," and consequences may be negative or beneficial. This section presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action in the context of other local, state, tribal, and federal management activities in the Puget Sound region on fish resources and related economic conditions.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative analysis is predicated on a review of all laws, policies, regulations, and plans that specifically pertain to fish-related management activities or that have an indirect negative or beneficial effect on fish resources and related economic conditions. These laws, policies, regulations, and plans are described in Section 1 and Appendix F. Because of the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or that will occur in the future in a quantitative manner. By reviewing all laws, policies, regulations, and plans, the analysis captures the objectives of any management activity that is occurring or planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of all other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on fish resources and related economic conditions.

Table 4.3.8.2-1 summarizes the potential cumulative effects to fish resources of implementing the Proposed Action with the effects of these existing laws, policies, regulations, and plans. Table 4.6-20 below summarizes the potential cumulative effects on economic conditions of other plans, policies and programs in the Puget Sound region.

The Proposed Action is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the

Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear.

1 Table 4.6-20. Federal, Tribal, Washington State, and local plans, policies, and programs that influence economic condition within the Puget
2 Sound Action Area (2004).

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	Description and Intent	Cumulative Effect when Combined with the Proposed Action
State of Washington, Chapter 36.70A RCW Growth Management – Planning by Selected Counties and Cities. Commonly referred to as the Growth Management Act (GMA). Adopted by the state in 1990.	The GMA guides development and adoption of comprehensive land use plans and development regulations of counties and cities within the state of Washington. The goals of the GMA include: "[m]aintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries" and "[p]rotect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water."	Under the Proposed Action, commercial fishing and sport fishing activities would occur at levels similar to the recent past. Employment and economic growth levels supported by these activities would have little effect on local and regional land use plans, and would not conflict with growth objectives of the GMA. Consequently, the Proposed Action, when considered in conjunction with the GMA, is predicted to result in no cumulative impact to economic resource conditions, because the Proposed Action would not change current or expected future economic conditions.
Puget Sound Regional Council VISION 2020 Strategy, 1995.	VISION 2020 is the long-range growth management, economic, and transportation strategy for the central Puget Sound region encompassing King, Kitsap, Pierce, and Snohomish counties. The strategy combines a public commitment to a growth management vision with the transportation investments and programs and economic strategy necessary to support that vision. VISION 2020 identifies the policies and key actions necessary to implement the overall strategy. The vision is for "diverse, economically and environmentally healthy communities framed by open space and connected by a high-quality multimodal transportation system that provides effective mobility for people and goods. The VISION 2020 strategy for managing growth, the economy, and transportation contains the following eight parts: urban growth areas; contiguous and orderly development; regional capital facilities; housing; rural areas; open space, resource protection, and critical areas; economics; and transportation. Together, these eight parts constitute the Multi-county Policies for King, Kitsap, Pierce, and Snohomish counties and meet the multi-county planning requirements of Washington's Growth Management Act.	From a growth and economic development perspective, the Proposed Action would maintain the status quo in regards to employment and personal income growth related to Puget Sound's commercial and sport fisheries. Consequently, the Proposed Action, when considered in conjunction with the VISION strategy, is predicted to result in no cumulative impact to economic resource conditions, because the Proposed Action would not change current or expected future economic conditions.

Table 4.6-20. Federal, Tribal, Washington State, and local plans, policies, and programs that influence economic condition within the Puget Sound Action Area (2004). *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	Description and Intent	Cumulative Effect when Combined with the Proposed Action
Economic Development Agency Plans and Programs	Several economic development councils and agencies operate in the counties surrounding Puget Sound. Economic development agencies normally include private, non-profit agencies that seek to encourage economic growth through the provision of various services to businesses and governments. Agencies in the Puget Sound region include, but are not limited to, the Economic Development Council of Thurston County, the Bellingham/Whatcom County Economic Development Council, the Kitsap Regional Economic Development Council, the Economic Development Council of Tacoma-Pierce County, the Economic Development Council of Seattle/King County, the Mason County Economic Development Council, and the Clallam County Economic Development Council. Economic development councils can affect regional economic growth and conditions in several ways, including through the development of economic development plans and business enhancement programs, and through business relocation assistance and planning, business promotion, coordination with local government economic development planning, and through the provision of socioeconomic data to the public and business community.	From a growth and economic development perspective, the Proposed Action would maintain the status quo in regards to employment and personal income growth related to Puget Sound's commercial and sport fisheries. Consequently, the Proposed Action, when considered in conjunction with economic development plans and programs in the Puget Sound region, is predicted to result in no cumulative impact to economic resource conditions because the Proposed Action would not change current or expected future economic conditions.
Local Plans, Policies, and Programs	Local activities that influence cumulative effects to economic conditions include, but are not limited to, capital improvement projects, growth and development plans, and economic and redevelopment plans.	The fisheries that would be allowed by the Proposed Action are predicted to have minimal to negligible effect on local economic conditions. Recent levels of local employment and growth supported by Puget Sound's commercial and sport salmon fisheries would be maintained by the Proposed Action. Consequently, the Proposed Action, when considered in conjunction with local plans, policies, and programs, is predicted to result in no cumulative impact to economic resource conditions because the Proposed Action would not change current or expected future economic conditions.

4.7 Environmental Justice

In consultation with the U.S. Environmental Protection Agency's (EPA) Office of Civil Rights and Environmental Justice, the National Marine Fisheries Service determined that Native American tribes were the only racial or socio-economic minorities identified as potentially affected Environmental Justice communities within the Puget Sound Action Area. EPA's Office of Civil Rights and Environmental Justice concurred that the focus of the Environmental Justice analysis should be on these tribes (personal communication with Mike Letourneau, U.S. Environmental Protection Agency, December 10, 2002). To guide the framework of Environmental Justice analysis, the EPA Office of Civil Rights and Environmental Justice has provided guidance to be used by all federal agencies conducting Environmental Justice analyses. NMFS has utilized this guidance for the Environmental Justice analysis herein. The EPA Environmental Justice guidelines offer a range of categories that might be utilized to indicate the presence or absence of Environmental Justice effects (U.S. Environmental Protection Agency 1998b). The Northwest Power Planning Council (2000) has also utilized a range of indicators to analyze human effects in a multi-cultural framework.

> Selection of indicators to appropriately represent potential impacts on tribal peoples . . . is necessarily cross-cultural. For example, while economic issues are of keen interest to Tribes due to their critical needs for jobs and improved incomes, the Tribes consider spiritual, cultural and life-style values associated with fish and wildlife of paramount importance – and these cannot be accurately represented by contemporary economic measures.
>
> Northwest Power Planning Council 2000.

Consequently, this indicator-based assessment draws topically from the range of indicator categories outlined by the US Environmental Protection Agency (1998b), from information provided in cultural and economic sections of Section 3 of this Environmental Impact Statement, and from other information relevant to the circumstances of the subject tribes. A brief discussion of each selected indicator follows.

Number of Salmon Harvested as an Indicator of Tribal Perspective of Value

Tribal spokespersons remind us that, in their culture, " . . . tribal peoples live as one with the land, the waters, and the fish and wildlife of their areas." From a tribal perspective, the value of the salmon is self-evident – and can be articulated by tribes in their own words, and on their own terms (Northwest Power Planning Council 2000). Some of this broad perspective is captured in Section 3.5 of this Environmental Impact Statement. Other tribal statements are found throughout tribal literature. The following examples are typical, but not exhaustive.

> Shellfish, all species of salmon and steelhead are what we depend on for our survival. This was a long time resource the Klallam people depended on for food. We still depend on it. . . . The water has long been a key religious asset for the Klallam people – a sacred thing, to get our strength from the food we have taken from the Sea water and the fresh water. It still is to this day.
>
> David Charles, Klallam Elder, in U.S. Minerals Management Service 1991.

> The Lummi people have historically been major producers of seafood products. Native to the cold, productive waters of Puget Sound and the North Pacific, Lummi fishermen have harvested, processed and marketed fish to others for thousands of years.
>
> Lummi Business Council, *in* U.S. Minerals Management Service 1991.

> The people acquired guardian spirits, many of whom were salt water spirits. The Salmon Spirit was particularly powerful and was the basis for many ceremonial rituals involving death and rebirth. It was felt that the Salmon's power should be recognized, and that the Salmon should be treated properly and not abused. . . . We know what the Earth and the Creator have given us to survive. We still have the same resources – and they are still providing us with a livelihood today.
>
> Ray Fryberg, Tulalip Councillor, *in* U.S. Minerals Management Service 1991.

Numbers of salmon harvested provide an indicator of the health of stocks, and represent an appropriate measure of relative harvest abundance and of tribal value. They are incorporated in this section as a value indicator that, from tribal perspective, "speaks for itself."

Cultural Viability

The U.S. Environmental Protection Agency (EPA) incorporates cultural impacts in its Exhibit 2 menu of factors that may be considered in any Environmental Justice analysis (U.S. Environmental Protection Agency 1998b). Where the "number of salmon" indicator facilitates tribal assertion of value and potential impact "in their own words," the "cultural viability" indicator is anthropologically based – and following analysis of Section 3.5 in this Environmental Impact Statement, will focus on impacts potentially affecting *cultural sustainability*, *passing on tribal knowledge to future tribal generations*, and *preservation of tribal identity*. These issues are interrelated – but taken together, are designed to carry the framework constructed in Section 3.5 through to this Environmental Justice assessment.

The information provided in Section 3.5, together with the tribal statements provided herein, identify that while salmon available to the tribes are diminished from Treaty times, the tribes continue to actively pursue salmon, depend on salmon as a key element of their present well-being, and value salmon highly for future generations. It is this contemporary relationship between the tribes and salmon that provides the baseline for the present analysis with respect to both the "number of salmon" and the "cultural viability" indicators.

Tribal Fishing Revenue

This tribal fishing indicator directly addresses economic revenue obtained by the tribes from sale of commercially-caught salmon and/or salmon eggs. Tribes also receive economic revenue from processing salmon, and from service activity associated with commercial and sport fishing. Such additional revenues are significant for some tribes, less so for others. However, in this assessment, comparison of direct revenues from sale of tribal catch serves as an accurate and sufficient measure to identify revenue-based Environmental Justice concerns associated with the four chinook salmon management alternatives.

Actual tribal revenues from salmon harvests vary from year to year due to changes in abundance and price. Table 4.7-1 provides information on recent revenues within the Puget Sound Action Area for the 17 fishing tribes included in this Environmental Impact Statement.

Table 4.7-1. Tribal salmon fishing revenue for the action area – 17 fishing tribes (estimates in thousands of dollars).

Species	1999 Revenue	2000 Revenue	2001 Revenue
Chinook	716	636	663
Chum	325	388	248
Pink	28	1	126
Coho	350	1,031	577
Sockeye	146	2,033	133
Steelhead	10	15	2
Salmon Egg Sales	303	746	1,807
Total – All Salmon	1,878	4,849	3,556

Source: Northwest Indian Fisheries Commission, February 2003.

Finally, this section addresses three indicators common to both tribal and non-tribal assessment of human effects: per capita income, level of poverty, and relative health/mortality. Available data will not necessarily sustain a quantitative calculation of precise effects linkages between salmon harvest under each alternative and impacts on these three indicators. However, information is sufficient to apply an ordinal measure of change to each indicator, where differences in tribal access/harvest between alternatives are deemed to be significant.

Annual Per Capita Income

This indicator is based on U.S. Bureau of the Census data published from Census 2000 for *American Indians and Alaska Natives* resident *on or near* each designated reservation. U.S. Census data is commonly relied on as a "best available" objective data source. (The data reported here include some

Native Americans resident on or near designated reservations who are not members of the 17 treaty fishing tribes.)

Percent Below Poverty Level

Data for this indicator come from the same U.S. Census 2000 source as per capita income. The data indicate the percentage of *American Indians and Alaska Natives* resident *on or near* each designated reservation with annual income below the federal poverty level.

Present populations and selected circumstances for the subject fishing tribes, as reported in the Census 2000 report, are presented in Table 4.7-2. Figures for all residents of the State of Washington are included for comparative purposes. Per capita and poverty data are for 1999. Data for the Jamestown S'Klallam Tribe are based on a sample size of 5 persons, and have not been relied upon. Actual circumstances at Jamestown S'Klallam have been reported to be within the range indicated for other tribes (Meyer 1993).

Table 4.7-2. Selected data for potentially affected tribes.

Tribe/State	Native Population	Per Capita Income	% below Poverty
Makah	1,076	$9,835	31
Lower Elwha	256	8,082	33
Jamestown	5	–	–
Port Gamble	461	8,539	18
Suquamish	503	13,613	13
Skokomish	518	8,500	32
Squaxin Island	325	8,698	33
Nisqually	314	11,072	18
Puyallup	1,386	12,439	26
Muckleshoot	1,029	9,914	29
Tulalip	1,875	10,623	29
Stillaguamish	78	7,609	13
Swinomish	611	8,712	36
Upper Skagit	139	5,523	60
Sauk Suiattle	41	8,127	5
Lummi	2,208	10,142	28
Nooksack	348	9,695	29
Washington State		$22,973	11

Source: U.S. Bureau of the Census. Census 2000, Summary File 3, Tables P6, P82, P157C and P159C.

Health and Mortality

The general health status of tribal peoples in Washington State, including within the Puget Sound Action Area considered here, were described in two 1992–1993 publications as “very poor” (Washington State Department of Health 1992), and “alarmingly poor” (American Indian Health Care Association 1993). The 1999 update to the *American Indian Health Care Delivery Plan* in Washington State confirms the conclusions from these earlier studies.

> AI/AN (American Indians/Alaska Natives) have a higher burden of serious disease, premature death, and poor birth outcomes than the population as a whole.
>
> American Indian Health Commission for Washington State and Washington State Department of Health (2001) (C-3).

> Since 1980, the total reported age-adjusted death rate for AI/AN in Washington State has consistently been higher than the death rate for the entire population of the State. . . . The general trend for overall AI/AN age-adjusted death rates since 1980 has been downward, but the gap between the AI/AN death rate and that for the general population has not narrowed appreciably.
>
> American Indian Health Commission for Washington State and Washington State Department of Health (2001) (C-7).

Recent work in the Pacific Northwest has identified a linkage between salmon resources and tribal health (i.e., Trafzer 1997; and Meyer Resources 1999). Commentary from a nurse from a neighbor salmon fishing tribe offers insight into relationships between salmon and tribal health.

> My specialty is psychosocial nursing. From my perspective, everything is tied together. Nothing is separate. The health of the kids is impacted every day. We see kids come in who are grossly overweight, and they're laying the groundwork for diabetes to come. The impact of the loss of the salmon, and the loss of the traditional grounds – the loss of the time with the elders to learn the ways and to feel as if they're part of this community, instead of feeling alienated not only from their neighbors and their families but also from the bigger community of humans – has a devastating effect on the kids. I have moms come in here eighteen years old who have been pregnant two or three times, who use substances and who don't teach their children the old ways because they don't know them. They don't feed their kids the old foods because they don't have any idea what they were. So the loss of the food and the salmon is monumental – and it is all tied together. . . . If you lose your foods, you lose part of your culture – and it has a devastating effect on the psyche. You also lose the social interaction. When we can fish, we spend time together – you share all the things that impact your life – and you plan together for the next year. Salmon is more important than just food.
>
> In sum, there's a huge connection between salmon and tribal health. Restoring salmon becomes a way of life. It restores physical activity. It restores mental health. It improves nutrition and thus restores physical health. It restores a traditional food source. It allows families to share time together and build connections between family members. It passes on traditions that are being lost.
>
> Chris Walsh, Yakama psycho-social nurse, *in* Meyer Resources 1999 (page 141).

While precise cause and effect quantification remains unspecified, it can be concluded that for the fish-eating tribes that are the subject of this analysis, salmon has played, and continues to play an important role in the health of tribal peoples – and consequently, is also a likely explanatory variable respecting observable differences in age-adjusted mortality between tribal peoples and residents of the State of Washington in general (Table 4.7-3).

Table 4.7-3. Relative mortality for tribal peoples compared to residents of Washington State.

Tribal Health Service, by Counties	Ratio of Tribal Mortality to Mortality for Residents of Washington State
Clallam	1.7
Skagit, Whatcom	1.7
King, Kitsap, Mason, Snohomish, Thurston	1.3
Pierce	0.7
Jefferson, Grays Harbor, Pacific	1.0

Source: Portland Area Indian Health Care Service 1994.

These data compare number of deaths per 100,000 population for American Indians/Alaska Natives against similar data for Washington State residents as a whole. Age-adjustment eliminates the impact of differences in age structure between the two populations, and allows for comparisons of death rates as though there were no age differences between populations (Portland Area Indian Health Care Service 1994).

As discussed in Subsection 4.2, four different scenarios of abundance and Canadian/Alaskan fisheries harvest were considered in this Environmental Impact Statement (Scenarios A through D). Considering the likelihood attributed to various assumptions by the Interdisciplinary Team, Scenario B (high abundance and maximum Canadian/Alaskan fisheries) is considered most likely, followed by Scenario A (high abundance and Canadian/Alaskan fisheries similar to those in 2003). Scenarios C (30% reduction in abundance and fisheries similar to those in 2003), and D (30% reduction in abundance and maximum Canadian/Alaskan fisheries) provide a basis for lower-bound sensitivity adjustments related to adverse exogenous events. In this section, discussion focuses on comparison of estimated tribal harvests for the four alternatives under Scenario B. Results from employing Scenarios A, C, or D are discussed following the discussion of Scenario B for each alternative. Although the catch and revenue results differ among scenarios, comparison of alternatives illustrated by Scenario B as well as the Environmental Justice conclusions reached in Table 4.7-13, are the same across scenarios.

4.7.1. Alternative 1 – Proposed Action/Status Quo

Alternative 1 would maintain present harvest opportunities and distribute catch broadly between areas and dependent tribes – supporting the existing array of economic, material, and cultural activities and values discussed here and in other report sections. Of the four alternative management regimes evaluated under Scenario B, Alternative 1 is estimated to provide approximately 4.5 times more salmon to the tribes than Alternative 2 (following), 6.5 times more salmon than Alternative 3, and 49 times more salmon than Alternative 4. Alternative 1 is projected to leave present tribal circumstance essentially unchanged – and consequently, is not estimated to generate either positive or adverse cultural, material, or health impacts for the tribes, measured from the present baseline.

<u>Scenario B (High Abundance and Maximum Canadian/Alaskan Fisheries)</u>

Integrating information on average fish size and prices developed from Washington Department of Fish and Wildlife (2002) with projected harvest impact under Scenario B (Appendix B), estimated tribal harvest and associated fishermen revenues under Alternative 1 are identified in Tables 4.7-4 and 4.7-5.

Table 4.7-4. Estimated tribal salmon harvested annually under Alternative 1, Scenario B.

Areas	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
Juan de Fuca Strait	2,363	23,879	26,419	1,374	10,450	739
North Puget Sound	29,238	101,652	255,859	731,587	152,189	532
South Puget Sound	33,241	140,279	47,700	316	196,350	663
Hood Canal	15,311	17,015	0	28,602	107,433	0
Full Action Area	80,153	282,825	329,978	761,879	466,422	1,934
Full Action Area – All Species						1,923,191

Under Alternative 1, Scenario B, an estimated 80,000 chinook, 283,000 coho, 330,000 sockeye, 762,000 pink salmon, 466,000 chum salmon, and almost 2,000 steelhead would be taken by the tribes annually. Applying average fish size and prices developed by the Washington Department of Fish and Wildlife (2002) to these numbers, Alternative 1, Scenario B, would generate an estimated $5.1 million in annual direct revenue for tribal fishermen.

Table 4.7-5. Estimated annual tribal salmon revenue, by species – Alternative 1, Scenario B.

Species	Estimated Annual Revenue (dollars)
Chinook	750,883
Coho	716,548
Sockeye	2,083,397
Pinks	494,615
Chums	1,076,968
Steelhead	9,516
All Species	$5,131,930

Commercial revenue estimates in Table 4.7-5 and for other alternatives may be underestimated to the extent that chum catch is diverted to higher-value egg sales.

These estimates maintain present harvest opportunities and distribute catch broadly between areas and dependent tribes – supporting the existing array of economic, material and cultural activities and values discussed here and in other EIS sections.

Of the four alternative management regimes evaluated under Scenario B, Alternative 1 is estimated to provide approximately 4.5 times more salmon to the tribes than Alternative 2 (discussed below), 6.5 times more salmon than Alternative 3, and 49 times more salmon than Alternative 4. Alternative 1 is projected to leave present tribal circumstance essentially unchanged – and consequently, is not estimated to generate either positive or adverse cultural, material, or health impacts for the tribes, measured from the present baseline.

Anticipated Environmental Justice effects are summarized in Table 4.7-13, following discussion of tribal impacts associated with each alternative.

Summary of Results for Alternative 1, Scenarios A, C, or D

Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D are presented in Table 4.7-6.

Table 4.7.6. Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D.

Area/Element	Scenario A	Scenario C	Scenario D
Juan de Fuca Harvest (#)	2,363	2,363	2,363
North Puget Sound (#)	31,813	22,434	20,281
South Puget Sound (#)	35,027	25,099	23,961
Hood Canal (#)	16,962	10,166	9,340
Chinook Harvest – All Areas (#)	86,165	60,062	55,945
Chinook Revenue ($)	$805,977	$575,902	$537,757
Chinook salmon: Difference from Scenario B.	+6,012 chinook +$55,094	-20,091 chinook -$174,981	-24,209 chinook -$213,126

Predicted tribal harvests for Puget Sound coho, sockeye, pink, chum, and steelhead would remain unchanged between Scenarios A, C, or D, and Scenario B (Table 4.7-6). Scenario A (high abundance and Canadian/Alaskan fisheries similar to 2003) would increase predicted tribal harvest under preferred Alternative 1 by 6,012 chinook compared with Scenario B. This represents a 7.5 percent increase in chinook harvest – and a 0.3 percent increase in tribal harvest of all species taken together. Tribal fishing revenue under Alternative 1 is predicted to increase by $55,094 (1.1 percent) – or $6 per capita. Predictably, assumption of 30 percent less harvest would decrease projected tribal harvest under Scenarios C or D significantly. Tribal harvest is predicted to decline by 25 to 30 percent and revenue by 3.4 to 4.1 percent under Scenarios C or D.

4.7.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Scenario B

Under Alternative 2, Scenario B, overall tribal chinook harvest is predicted to decline by an estimated 29,265 fish (78%), compared to Alternative 1 (Table 4.7-7). Losses would be most prevalent in North and South Puget Sound. Catch in the Strait of Juan de Fuca would be eliminated. Harvest in Hood Canal is predicted to increase by more than 4,000 chinook.

Table 4.7-7. Number of tribal salmon caught annually under Alternative 2, Scenario B.

	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
Strait of Juan de Fuca	0	1,725	0	0	2	610
North Puget Sound	8,349	33,142	0	83,400	1,808	227
South Puget Sound	22,738	72,889	0	316	81,163	653
Hood Canal	19,802	4,493	0	25,792	65,813	0
Full Action Area	50,888	112,249	0	109,508	148,786	1,490
Full Action Area – All species	422,921					

Tribal coho catches are estimated to decline from an Alternative 1 catch of 24,000 fish to less than 2,000 fish in the Strait of Juan de Fuca under Alternative 2. Coho catches in North Puget Sound are predicted to decline from 102,000 to 33,000 fish. Tribal coho harvest in South Puget Sound is predicted to decline by an estimated 67,000 salmon. Estimated catches in Hood Canal are predicted to decline by 12,500 coho. Over all areas, tribal harvesters are estimated to lose 170,000 coho under Alternative 2, Scenario B, compared to Alternative 1, Scenario B.

Under Alternative 2, Scenario B, no tribal harvest of sockeye salmon would occur. Compared to Alternative 1, this would represent an estimated loss of 282,000 sockeye to North Puget Sound and Strait of Juan de Fuca tribal fishers, and a lost tribal catch of approximately 48,000 sockeye salmon in South Puget Sound.

Tribal catch of pink salmon is expected to decline by an estimated 652,000 fish under Alternative 2, Scenario B. Lost catch in the Strait of Juan de Fuca is estimated to exceed 1,000 pink salmon. In North Puget Sound, the loss of pink salmon to tribal fisherman is estimated to be 649,000. In Hood Canal, catch of pink salmon is predicted to decline by about 3,000. The South Puget Sound pink salmon fisheries would remain about the same as with Alternative 1.

Starting from the Alternative 1 baseline, tribal chum salmon harvest is predicted to decline by an estimated 318,000 fish under Alternative 2. In the Strait of Juan de Fuca and North Puget Sound, the estimated loss of chum salmon to tribal fishermen would be approximately 160,000 fish. An estimated 157,000 chum salmon would be lost from the South Puget Sound and Hood Canal tribal harvest – a decline of 52 percent.

Under Scenario B, the loss of steelhead to the tribal harvest is predicted to be 400 fish with Alternative 2, compared to Alternative 1.

Overall, Alternative 2 is predicted to provide an all-species catch of approximately 423,000 salmon to the tribes. This is predicted to result in an all-species reduction in catch of 1.5 million salmon (78%) compared to the Alternative 1 baseline.

Using average fish size and prices developed by Washington Department of Fish and Wildlife (2002), Alternative 2 is predicted to provide annual commercial direct revenue to tribal fishermen of $1,137,000 – a loss of $4 million from the Alternative 1 baseline.

Under Scenario B, the estimated impacts of Alternative 2 would greatly diminish, and in some cases eliminate, the opportunity to be a fisherman – a respected lifestyle in tribal society. Many tribal fishermen would lose their investment in boats and gear, and the tribal ability to pass on fishing knowledge to their children and grandchildren would be impaired.

Other cultural opportunities to provide salmon as food, to share or trade salmon within tribal communities, and to conduct ceremonies would be eliminated or substantially reduced for the tribes. Information provided earlier in this subsection suggests that this, in turn, could be expected to have an adverse impact on the physical, spiritual, and cultural health of tribal peoples who already experience adverse circumstances relative to residents of the State of Washington in general (Tables 4.7-2 and 4.7-3).

Alternative 2 would significantly worsen the already adverse economic and health circumstances experienced by the 17 tribes addressed in this Environmental Impact Statement, relative to residents of the State of Washington in general when compared with Alternative 1, Scenario B.

Alternative 2 stands second to Alternative 3 (described below) in terms of adversity for the tribes. However, considered alone, Alternative 2 would still generate disproportionately high and adverse human impacts across tribal groups. Given the dependence of tribes on salmon, and the unique cultural linkage between salmon and tribal peoples, these adverse impacts would resonate far more strongly among the tribes than among the non-tribal population of Washington State as a whole.

Summary of Results for Alternative 2, Scenarios A, C, or D

Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D are presented in Table 4.7-8. Predicted tribal harvests for Puget Sound coho, sockeye, pink, chum, and steelhead would remain unchanged between Scenarios A, C, or D, and Scenario B (Table 4.7-8).

Table 4.7-8. Predicted tribal harvests of chinook salmon under Alternative 2, Scenarios A, C, or D.

Area/Element	Scenario A	Scenario C	Scenario D
Juan de Fuca Harvest (#)	0	0	0
North Puget Sound (#)	8,531	415	391
South Puget Sound (#)	24,150	11,523	10,537
Hood Canal (#)	21,213	12,745	11,608
Chinook Harvest – All Areas (#)	53,893	24,683	22,536
Chinook Revenue ($)	$445,065	$193,445	$176,619
Chinook salmon: Difference from Scenario B.	+3,005 chinook +$24,049	-26,683 chinook -$227,571	-28,351 chinook -$244,397

If Scenario A were implemented, tribal harvest would be predicted to increase under Alternative 2 by 3,005 chinook salmon compared to Scenario B. This would represent a 6.0 percent increase in chinook harvest – and a 0.2 percent increase in tribal harvest of all species taken together. Tribal fishing revenue under Alternative 1 would increase by $24,049 (0.5 percent), or $3 per capita. Predictably, assumption of 30 percent less harvest would decrease projected tribal harvest under Scenarios C or D significantly. Tribal harvest is predicted to decline by 56 to 58 percent and revenue by 3.4 to 4.1 percent under Alternative 2, Scenarios C or D because of the 30 percent decline in abundance in these two scenarios.

4.7.3 Alternative 3 – Escapement Goal Management at the Population Level

<u>Scenario B</u>

Under Alternative 3, Scenario B, overall tribal catch of salmon is predicted to be reduced by 85 percent compared to Alternative 1 – a loss of 1.6 million salmon each year (Table 4.7-9). Associated annual loss of direct tribal revenue from fish sales is estimated at $4.2 million.

Table 4.7-9. Estimated tribal salmon numbers harvested annually under Alternative 3, Scenario B.

Areas	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
Strait of Juan de Fuca	0	1,725	0	0	2	610
North Puget Sound	0	143	0	0	1,057	227
South Puget Sound	22,738	72,889	0	316	81,163	653
Hood Canal	19,802	4,493	0	25,792	65,813	0
Full Action Area	42,540	79,250	0	26,108	148,035	1,490
Full Action Area – All Species						297,421

Principal predicted losses would be to tribal harvests of chinook salmon, down from 80,000 under Alternative 1 to 42,540 pieces, chiefly in North and South Puget Sound; coho down from 283,000 to 79,000 fish, chiefly from North and South Puget Sound; sockeye with 330,000 salmon lost from North and South Puget Sound; pink salmon in North Puget Sound, down to zero from 731,000 fish; and chum, down from 466,000 to 148,000, with all subareas adversely affected.

Alternative 3, Scenario B, would be more adverse than Alternative 2, Scenario B. It would significantly worsen the already adverse economic, health, and cultural circumstances experienced by the 17 tribes within the Puget Sound Action Area.

<u>Summary of Results for Alternative 3, Scenarios A, C, or D</u>

Predicted tribal harvests of chinook salmon under Alternative 1, Scenarios A, C, or D are presented in Table 4.7-10.

Table 4.7-10. Predicted tribal harvests of chinook salmon under Alternative 3, Scenarios A, C, or D.

Area/Element	Scenario A	Scenario C	Scenario D
Juan de Fuca Harvest (#)	0	0	0
North Puget Sound (#)	0	0	0
South Puget Sound (#)	24,150	11,523	10,537
Hood Canal (#)	21,213	12,745	11,608
Chinook Harvest – All Areas (#)	45,363	24,267	22,145
Chinook Revenue ($)	$355,519	$190,193	$173,555
Chinook salmon: Difference from Scenario B.	+2,822 chinook +$22,125	-18,273 chinook -$143,201	-20,395 chinook -$159,839

Predicted tribal harvests for Puget Sound coho, sockeye, pink, chum, and steelhead would remain unchanged between Scenarios A, C, or D, and Scenario B (Table 4.7-10). If Scenario A were implemented, tribal harvest under Alternative 3 would be predicted to increase by 2,822 chinook when compared with Scenario B. This would represent a 6.6 percent increase in chinook harvest, and a 0.2 percent increase in tribal harvest of all species taken together. Tribal fishing revenue under Alternative 1 would increase by $22,125 (0.4%), or $3 per capita. Predictably, assumption of 30 percent less harvest would decrease projected tribal harvest under Scenarios C or D significantly. Tribal harvest is predicted to decline by 43 to 48 percent, and revenue by 2.8 to 3.1 percent under Alternative 3, Scenarios C or D.

4.7.4 Alternative 4 – No Action/No Authorized Take, Scenario B.

Under Alternative 4, Scenario B, potential tribal harvests of four salmon species – chinook, coho, sockeye, and pink – are predicted to cease throughout the Puget Sound Action Area (Table 4.7-11). Potential tribal harvest of chum salmon is predicted to occur only in freshwater areas, principally in South Puget Sound, with small predicted catches in North Puget Sound and Hood Canal, and miniscule amounts predicted from Strait of Juan de Fuca streams. Total tribal chum salmon harvests are projected to decline by 92 percent under Alternative 4, from an estimated 466,000 fish under the Proposed Action (Alternative 1), to 37,800 fish.

Table 4.7-11. Estimated tribal salmon numbers harvested annually under Alternative 4, Scenario B.

Areas	Chinook	Coho	Sockeye	Pink	Chum	Steelhead
Juan de Fuca Strait	0	0	0	0	2	609
North Sound	0	0	0	0	1,057	227
South Sound	0	0	0	0	36,389	512
Hood Canal	0	0	0	0	352	0
Full Action Area	0	0	0	0	37,800	1,348
Full Action Area – All Species						39,148

Steelhead harvests by the tribes are predicted to decline by an estimated 30 percent, from 1,934 fish under Alternative 1, to 1,348 fish under Alternative 4. These catches would occur only in fresh water.

Summing lost tribal harvests for all salmonid species compared to baseline (Alternative 1) conditions, it is predicted that the tribes would lose almost 1.9 million salmon under Alternative 4, virtually eliminating access to the salmon resources reserved to them in the Stevens treaties. These impacts would, in turn, greatly diminish or eliminate the opportunity to pursue the occupation of tribal fisherman.

Other cultural opportunities to provide salmon as food, share or trade salmon within tribal communities, and conduct ceremonies would be eliminated or greatly reduced, and the physical and spiritual health of tribal peoples would be expected to decline.

The tribal peoples within the Puget Sound Action Area are already impoverished relative to residents of the State as a whole (Table 4.7-2). Using average fish size and prices for each species developed by Washington Department of Fish and Wildlife (2002), it is predicted that the subject tribes would receive approximately $107,000 from salmon sales under Alternative 4 – 2 percent of the revenues predicted with Alternative 1. Additionally, tribal fishermen, with no marine areas to fish, would lose their investments in boats, gear, and – over time – their fishing knowledge, should these losses occur.

The projected adverse impacts identified here show that Alternative 4 is predicted to have the most disproportionately high and adverse human and/or environmental effects on the tribes of any alternative being considered, and would exacerbate existing adverse differences in economic well-being and health between the tribes and Washington State residents as a whole. The unique linkage between salmon and tribal culture/values renders these adverse differences between the well-being of the tribes and residents of the State of Washington in general more pronounced under Alternative 4 than the other alternatives under consideration.

<u>Summary of Results for Alternative 4, Scenarios A, C, or D</u>

Predicted tribal harvests of chinook salmon under Alternative 4, Scenarios A, C, or D are presented in Table 4.7-12. Chinook catch under all scenarios would be zero, since Alternative 4 is defined as no take of listed chinook salmon.

Table 4.7-12. Predicted tribal harvests of chinook salmon under Alternative 4, Scenarios A, C, or D.

Area/Element	Scenario A	Scenario C	Scenario D
Juan de Fuca Harvest (#)	0	0	0
North Puget Sound (#)	0	0	0
South Puget Sound (#)	0	0	0
Hood Canal (#)	0	0	0
Chinook Harvest – All Areas (#)	0	0	0
Chinook Revenue ($)	0	0	0
Chinook salmon: Difference from Scenario B.	--- ---	--- ---	--- ---

Predicted tribal harvests for Puget Sound coho, sockeye, pink, chum, and steelhead would remain unchanged between Scenarios A, C, or D, and Scenario B.

4.7.5 Comparison of the Effects of Management Alternatives on the Tribes

Table 4.7-13 summarizes the findings of this section – arrayed by Environmental Justice indicator. The comparison uses the results of Scenario B, but the results follow the same pattern regardless of which scenario is used.

Table 4.7-13. Summary of environmental justice indicators associated with potential impacts from alternative management plans under Scenario B. [1]

Tribal Indicator	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Number of Salmon Harvested	1,923,191	422,921	297,421	39,148
Cultural Viability	Maintains status quo. Not predicted to have high disproportionate or adverse impact.	Disproportionate and substantial adverse impact to: *Cultural sustainability. *Tribal identity. *Passing on tribal knowledge.	Disproportionate and substantial adverse impact to: *Cultural sustainability. *Tribal identity. *Passing on tribal knowledge.	Disproportionate and substantial adverse impact to: *Cultural sustainability. *Tribal identity. *Passing on tribal knowledge.
Catch Revenue	$5,131,930	$1,137,426	$925,339	$106,976
Per Capita Income*	No change	Minus $358 /person.	Minus $376 /person.	Minus $450/person.
Poverty	No change	Substantial and disproportionate increase.	Substantial and disproportionate increase.	Substantial and disproportionate increase.
Health/Mortality	Maintains status quo. Not predicted to have high disproportionate or adverse impact.	Disproportionately adverse to health.	Disproportionately adverse to health.	Disproportionate and substantial threat to health.

[1] Based on tribal population estimates in Table 4.7-2.

The alternatives considered in this Environmental Impact Statement balance issues of salmon harvest and non-harvest, each of which involves its own affected constituencies, among tribes, and within the Washington State population as a whole. The tribes considered here retained guaranteed access to salmon in their treaties – in order to allow them to sustain themselves and prosper. In treaty times, and today, salmon play a unique role for the tribes. The loss of salmon as a viable resource upon which the fishing tribes depend economically and culturally would be an irretrievable loss to tribal culture.

Notwithstanding treaty guarantees, the life of the tribal peoples subject to this impact analysis remains difficult, compared to non-tribal residents of the State. Poverty is unacceptably high. Incomes and health circumstances are adverse. Cultural viability is often threatened.

Salmon remain critically important as the tribes struggle to survive – providing food and badly needed economic returns, a continuing basis for culture and lifestyle, and hope of improvement for children and grandchildren in the future. Comparatively, on the non-tribal side, salmon are important to non-tribal commercial and sport fishermen – but within a context that is characterized by far more diversity of economic opportunity, higher levels of material well-being, superior health and less direct cultural linkage with salmon for the majority of non-tribal citizens of Washington State.

Given this context, Table 4.7-13 and the preceding discussion identify that Alternatives 2, 3, or 4 would pose disproportionately-high and substantial adverse impacts to tribal culture, health and material well-being, differing only in degree. It is concluded that the severe potential impacts associated with any of these three alternatives render them unjust to the tribes when balanced against impacts to the people of Washington State as a whole. No mitigation measures have been identified that could effectively offset or reduce predicted Environmental Justice impacts to the tribes that would result from Alternative 2, Alternative 3, or Alternative 4.

4.7.6 Indirect and Cumulative Effects

4.7.6.1. Indirect Effects

Alternative 3 or 4 would specifically preclude fishing in marine areas. Alternative 2 would provide for only a modest marine chinook salmon fishery in North Puget Sound. In addition to direct harvest effects, these options could lead to increased crowding and/or competition between tribal fishers in some freshwater areas, and increased pressure on those freshwater stocks and on tribal fishing efficiencies.

The Samish and the Snoqualmie Tribes are afforded federal recognition, and demonstrate an historic fishing tradition. They are not presently recognized by the federal government to have status as treaty fishing tribes. Tribal spokespersons/experts report that a small number of their members have taken out non-tribal commercial salmon fishing licenses, but most of their salmon for ceremonies are currently obtained from one or more of the fishing tribes discussed in this Environmental Impact Statement. Consequently, Alternatives 2, 3, or 4 would not pose a present substantial threat with respect to material well-being or health for these tribes, but would make it more difficult for them to obtain salmon for ceremonial purposes and to continue cultural practices. As with other tribes, Alternative 1 would maintain current linkages between salmon and Samish and Snoqualmie peoples.

4.7.6.2 Cumulative Effects

NEPA defines cumulative effects as " . . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR1508.7). For purposes of this discussion, the terms "effects" and "impacts" will be considered synonymously with "consequences," and consequences may be negative or beneficial. This subsection presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action in the context of other local, state, tribal, and federal management activities in the Puget Sound region on fish resources and related economic conditions.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative effects analysis is predicated on a review of applicable laws, policies, regulations, and plans that specifically pertain to fish-related management activities, or that have an indirect negative or beneficial effect on fish resources and related economic conditions. These laws, policies, regulations, and plans are described in section 1 and Appendix F. Because of the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or will occur in the future in a quantitative manner. By reviewing applicable laws, policies, regulations, and plans, the analysis captures the objectives of management activities that are occurring or planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on environmental justice communities. Table 4.7-14 below summarizes the potential cumulative effects on environmental justice communities of other plans, policies and programs in the Puget Sound region in addition to the Proposed Action.

The Proposed Action (Alternative 1) is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear. Alternative 1 would maintain present-day distributions of salmon to the tribes, and is preferred. Due to alterations in habitat, stream water quality and other factors, the amount of salmon available to the subject tribes is substantially less than at treaty times. Consequently, management of salmon harvests as described in Alternative 1 is necessary, but may not be sufficient, to deal with cumulative Environmental Justice concerns arising from other sources. Alternatives 2, 3, or 4 would substantially reduce tribal access to salmon fisheries, and therefore would significantly worsen tribal material and cultural circumstance.

Table 4.7-14. Federal, Tribal, Washington State, and local plans, policies, and programs predicted to have a cumulative impact on environmental justice communities within the Puget Sound Action Area (2004).

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	Description and Intent	Cumulative Effect when Combined with the Proposed Action
U.S. v. Washington (Boldt Decision)	The Boldt Decision reaffirmed the rights of Washington Indian tribes to fish in accustomed places, and allocated 50 percent of the annual catch to treaty tribes. Judge Boldt held that the government's promise to secure the fisheries for the tribes was central to the treaty-making process, and that the tribes had an original right to the fish, which they extended to white settlers. Judge Boldt ordered the state to take action to limit fishing by non-Indians. The court decision recognized that "assuring proper spawning escapement is the basic element of conservation involved in restricting the harvest of salmon and Steelhead." The decision further defined adequate production escapement as "… that level of escapement from each fishery which will produce viable offspring in numbers to fully utilize all natural spawning grounds and propagation facilities reasonable and necessary for conservation of the resource…"	For treaty tribes considered as Environmental Justice communities, the legal mandates prescribed in U.S. v. Washington in conjunction with the Proposed Action would be predicted to result in a beneficial impact to Tribes considered to be Environmental Justice communities. Both the Proposed Action and U.S.v. Washington require that Tribes have access to fishery resources.
EPA Environmental Justice Policy under Executive Order 12898	The Executive Order requires that EPA maintain oversight responsibility on ensuring that federal agencies assess whether their actions may result in a disproportionate impact on environmental justice communities. Also, EPA oversees that other federal agencies strive to avoid disproportionate impacts when they are predicted to occur	In keeping with the intent of the Executive Order, it is predicted that the Proposed Action would not result in a cumulative or disproportionate impact to Environmental Justice communities.

4.8 Wildlife

This section assesses the potential impacts of the Proposed Action or alternatives on marine birds, mammals, and invertebrates, including threatened and endangered wildlife species. Effects are described by fishery gear type and location (i.e., marine and freshwater terminal areas).

4.8.1 Marine Birds

The susceptibility of marine birds as a bycatch of Puget Sound salmon fishing depends largely on three factors: the type of fishing gear, the occurrence of birds during the fishing seasons, and bird diving behavior. The following discussion considers the effects of five fishing methods: sport, purse seine, beach seine, reef net, and gillnet.

Noviello (1999) studied seabird interaction with the Strait of Juan de Fuca and Puget Sound "hook and line" sport fishery (Marine Catch Areas 4, 5, 8-2, and 10) in 1997 and 1998, and observed no bird mortalities in 1,090 observed "hook-ups." (The only birds hooked were four immature gulls, all released alive.)

Purse seine nets are usually built of heavy nylon twine, with a small mesh (3.5 to 4 inches) that is probably visible to diving seabirds. Such nets, therefore, are probably easily avoided, or easily escaped from, by most seabirds. Anderson (1993) found that of 179 seabirds (mainly rhinoceros auklets, common murres, pigeon guillemots, and western grebes) observed encircled by seine nets in the 1990 to 1992 Puget Sound coho and chum salmon fisheries, 74 percent escaped, 21 percent were entangled but released unharmed, and only 5 percent were killed or injured. The mortality rate for this fishery was a very low 0.026 seabirds killed per net set. Further, the Washington Department of Fish & Wildlife (WDFW) now requires that purse seines have at least four 12-inch cork-line bird openings to facilitate escape by captured seabirds. The small tribal and non-tribal beach seine fisheries are similar. Because they operate in shallow, nearshore water with constant human presence, few, if any, seabirds are captured in this fishery. Consequently, neither purse seine nor beach seine fisheries are substantial sources of seabird mortality.

Reef net fishing is practiced by non-tribal fishers in Marine Catch Areas 7 and 7A. Reef nets are highly selective fishing gear with a design that prevents bycatch mortality. The mesh size is sufficiently small (3.5 inches) to avoid entanglement as the net is lifted out of the water and the contents spilled into a holding pen. Non-target species are then released from the holding pen unharmed.

Gillnet fisheries have been shown to entangle seabirds throughout the world (e.g., Christensen and Lear 1977; Piatt and Nettleship 1987; DeGange et al. 1993; and Julian and Beeson 1998), including Puget

Sound (Pierce et al. 1995; and Melvin et al. 1999). Gill nets have mesh openings large enough (5 to 7 inches) to entangle seabirds, and are made of monofilament nylon line, which is virtually invisible to pursuit diving seabirds.

However, not all marine birds are susceptible to the Puget Sound gillnet fishery. Gulls, kittiwakes, jaegers, terns, phalaropes, and dabbling ducks generally do not face a risk of bycatch because they forage at the surface, rather than diving to depths where nets are used. Fulmars and shearwaters are pelagic seabirds that do not enter very far into the Strait of Juan de Fuca and, therefore, do not often encounter net fisheries. Other species of ducks do not arrive in Puget Sound in great numbers until the fisheries are nearly complete. Using fish landings as a basis of effort, 90 percent of the commercial salmon fishery in the Strait of Juan de Fuca and North Puget Sound is complete by October, and November fishing in all catch areas is generally 80 to 85 percent completed by November 15. Subsection 3.8.2, Marine Birds – Affected Environment, describes marine bird migration through the Puget Sound Action area. Further, sea ducks and diving ducks are generally not fast-pursuit predators, feeding instead on more sedentary benthic prey such as mussels, clams, crabs, and algae. Entanglement in gillnets may require birds striking the net at a fast speed.

Large numbers of western grebe overlap with the late-season chum fisheries (Courtney et al. 1997) and, because they are pursuit divers, would be expected show up in the bycatch. Currently-available data, however, do not indicate that western grebes are susceptible to the gillnet fishery. This apparent immunity may be due to the bird's nocturnal foraging behavior (Clowater 1998), but further research may be required to substantiate this explanation.

What remain are diurnal foraging pursuit predators such as cormorants, loons, and alcids like rhinoceros auklets, common murres, pigeon guillemots, and marbled murrelets (the latter are addressed further in Subsection 4.8.4, below). Loons and cormorants have been identified as bycatch in gillnet fisheries in Newfoundland (Piatt and Nettleship 1987), and California (Julian and Beeson 1998), but in small numbers. Although cormorants are found year-around in Puget Sound and the Strait of Juan de Fuca, they, along with loons, do not reach their seasonal peak until December, after almost all salmon fishing is complete. Pierce et al. (1996) and Melvin et al. (1999) observed no loon or cormorant entanglements during the seabird interaction studies of sockeye fisheries within Marine Catch Areas 7 and 7A.

All types of fishing gear can become lost as a result of entanglement with bottom structures, logs and debris, or because of storms, flood events and other occurrences. Of the gears used to harvest salmon, monofilament gillnet and angling gears are the most common gear types lost. Submerged gillnets typically drift until they become entangled on submerged features or structures, where they may impact bottom-dwelling organisms. Seabirds, mammals, fish and other animals become entangled in derelict nets or entangle in or ingest monofilament fishing line. Nets and pots lying on the seabed continue to entangle fish and wildlife species for years after they are lost or abandoned.

In 2004, the Greystone Foundation provided funding to the Northwest Straits Foundation (NWSF), who contracted with Natural Resource Consultants to conduct derelict fishing gear removal in the Strait of Juan de Fuca and the San Juan Islands. In the 46 nets encountered in this project, 43 dead seabirds were recovered, and bone evidence below the nets suggests that hundreds and perhaps over one thousand other birds may have been killed. These results are too recent (April 5, 2004) for rigorous estimates of cumulative impacts to populations of seabirds, marine mammals and other wildlife to be available. Such estimates will allow managers to determine what relative impact this environmental problem is exerting on seabird and mammal populations.

Worldwide, alcids are the most common seabird caught in coastal gillnet fisheries, with common murres the most commonly caught species (Melvin et al. 1999). These birds are most susceptible because 1) they swim very rapidly in dive-pursuit of prey and, therefore, likely hit gillnets with enough force to cause entanglement; 2) they tend to form large aggregations; and 3) they tend to pursue a common prey with salmon (e.g., herring). Collectively, then, large numbers of these fast diving birds may be found in association with salmon, which are targeted by gillnet fishers, resulting in bycatch of the alcids. Recognizing that alcid mortality due to gillnet fishing is the only potentially substantial seabird fishery interaction issue, only pigeon guillemots, rhinoceros auklets, and common murres are addressed further in this subsection. Marbled murrelets are addressed in the Threatened and Endangered Species subsection (4.8.4 below).

Pigeon Guillemot

Guillemots have shown susceptibility to gillnet fisheries in some regions. Piatt and Nettleship (1987) estimated that the Newfoundland cod and salmon gillnet fishery killed approximately 2,000 black guillemots annually between 1981 and 1984. In contrast, Pierce et al. (1996) did not report the presence of pigeon guillemots during the 1994 sockeye fishery Marine Catch Areas 7 and 7A, and in a 1996 sockeye test fishery in Marine Catch Area 7, only one pigeon guillemot was caught in 642 gillnet sets (Melvin et al. 1999). Also, Julian and Beeson (1998) recorded no entanglements of pigeon guillemots during 1990 to 1994 gillnet fishing in central California that was killing up to 2,300 common murres annually (Forney et al. 2001). Guillemots in Washington are probably not susceptible to the Puget Sound gillnet fishery because they forage on gunnels, pricklebacks, and sculpins (Drent 1965; and

Koelink 1972), generally in shallow, nearshore waters. Gunnels, pricklebacks, and sculpins are more sedentary than schooling fish such as herring, and therefore probably do not require fast pursuit to capture.

Rhinoceros Auklet

Thompson et al. (1998) estimated that the 1994 sockeye fishery in Marine Catch Areas 7 and 7A killed less than 0.8 percent of the Washington breeding auklet population (36,800), well below the 6 percent mortality level where population stability concerns occur. Further, Thompson et al. (1998) observed no adults during the fall chum salmon fishery, confirming that most auklets winter outside Washington's inner marine waters (Angell and Balcomb 1982). Consequently, while the sockeye fishery in Marine Catch Areas 7 and 7A killed relatively large numbers of rhinoceros auklets in the 1990s, this mortality does not appear to exceed biological thresholds of concern.

Common Murre

WDFW estimated that the 1994 sockeye fishery in Marine Catch Areas 7 and 7A alone killed approximately 2,700 common murres (Pierce et al. 1996). If a constant rate of entanglement of murres is assumed throughout all Puget Sound fisheries (which is not realistic), and the Marine Catch Area 7 and 7A sockeye fisheries are assumed to represent about 45 percent of all fishing effort (based on number of landings during the period 1996 through 2001), then a maximum of about 6,100 murres may have been killed in 1994. If, following Thompson et al. (1998), 70 percent of the murres killed were adults, then the 1994 adult mortality may have been approximately 4,300. This represents 73 percent of the estimated 1994 Washington breeding population of 5,900 (Carter et al. 2001), well beyond the 6 to 12 percent mortality at which maintenance of a stable breeding population becomes difficult, if not impossible (Piatt et al. 1984). However, it is known that this degree of mortality was not the case. If the 1994 mortality exacted such a toll on the Washington breeding murre population, a dramatic decline would have been observed in the 1995 breeding population, rather than the observed doubling from 5,900 to 9,600 (Carter et al. 2001) or 13,600 murres (*TENYO MARU* Oil Spill Natural Resources Trustees 2000).

Based on the studies conducted by Thompson et al. (1998), a considerable, but unknown, proportion of the murres killed in the sockeye salmon fishery originated from Oregon, where the breeding population exceeds 700,000 (personal communication with Roy Lowe, U.S. Fish and Wildlife Service, Refuge Biologist, February 25, 2003). Thompson et al. contend that during the peak of the sockeye fishing season, Washington murres are still attending colonies, while Oregon murres, which complete their breeding cycle a month or more earlier, have already dispersed from breeding sites and then dominate the waters of Puget Sound during the sockeye fishery. The exact ratio of Oregon versus Washington birds in the Puget Sound salmon fishery bycatch is currently unknown, however (Thompson et al. 1998), numbers of common murres found in Washington waters in late summer far exceed the Washington breeding population (Manuwal and Carter 2001). The maximum adult mortality of 4,300 murres is less than 1 percent of the combined Oregon and Washington breeding population, which is not a substantial proportion of the two-state population. Further, the Washington and Oregon birds are all part of a single subspecies (*Uria aalge californica*) that includes birds from California (approximately 350,000 adults), and British Columbia (approximately 10,000 adults) (Carter et al. 2001). Finally, given that fishing effort is now substantially lower than in the 1990s when the Pierce et al. (1996) and Thompson et al. (1998) studies were conducted (personal communication with Will Beattie, Northwest Indian Fisheries Commission, December 19, 2003), the significance of gillnet entanglement mortality in Puget Sound is likely further reduced. Nevertheless, current radio-telemetry studies by Hamel and Parrish are aimed at determining the presence of Washington-bred murres coincident with the salmon gillnet fisheries to verify whether this breeding population is at risk from Puget Sound fisheries (personal communication with Julia Parrish, University of Washington, Associate Professor, February 13, 2003).

4.8.1.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action would involve a fishery effort similar to (or substantially less than) the fishing that occurred in Puget Sound and the Strait of Juan de Fuca during the 1990s, except seabird bycatch would likely be greatly reduced during the Marine Catch Area 7 and 7A sockeye and pink salmon gillnet fishery, through the implementation of the “bird web” net design and dawn hours fishing restrictions originally proposed by Melvin et al. (1999). Net modification designs for purse seines and gillnets, and area and time closures are required by the Washington Department of Fish (WDFW) and Wildlife in areas frequented by marbled murrelets. WDFW requires that 1) gillnets fishing in Marine Catch Areas 7 and 7A use “bird webs” (a 20-mesh panel of small diameter, highly-visible white nylon across the top of the net); 2) purse seines in all areas have a 12-inch space between corks; 3) shoreline areas in Marine Catch Areas 7 and 12 close to gillnet fishing; and 4) gillnet fisheries remain closed during early morning hours. These requirements, estimated to reduce the seabird bycatch by approximately 70 to 75 percent (based on research results from Melvin et al. 1999), may ensure that the annual gillnet mortality of Washington common murres does not exceed the maximum mortality to sustain a stable population, although continued research is needed to ensure this is the case. Bycatch mortality of rhinoceros auklets and pigeon guillemots was considered to be well below significance levels prior to implementation of the bird bycatch reduction requirements (Pierce et al. 1996;

Thompson et al. 1998; and Melvin et al. 1999). These requirements should safely ensure the annual bycatch stays sufficiently low. Finally, the overall fishing effort in Marine Catch Areas 7 and 7A is considerably lower than that compared to effort in previous years which were the basis of the estimates in the Environmental Impact Statement evaluation.

4.8.1.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, no net fisheries would occur in marine areas with the exception of small-scale, nearshore, set gillnet, and beach seine fisheries in Dungeness Bay (Marine Catch Area 6D), Tulalip Harbor (Marine Catch Area 8D), and adjacent to the Hoodsport Hatchery in Hood Canal (Marine Catch Area 12H). Consequently, there would be no bycatch of alcids, or any marine birds for that matter. Therefore, fisheries under Alternative 2 are predicted to have no impact to marine bird populations. This alternative would entirely eliminate the small bycatch predicted to occur with the Proposed Action (Alternative 1). Because marine bird bycatch would not occur under Alternative 2, it would be considered to have a beneficial impact when compared to Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.1.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

The scale and distribution of marine net fisheries for salmon under Alternative 3 would be similar to those under Alternative 2, except that all potential salmon harvest would be limited to freshwater terminal areas (major rivers) only. No salmon fishing of any kind would occur in the Strait of Juan de Fuca or Puget Sound marine waters. The small fisheries occurring in Dungeness Bay, Tulalip Harbor and adjacent to the Hoodsport Hatchery under Alternative 2 would not occur under Alternative 3. Consequently, there would be no bycatch of alcids, or any marine birds. As with Alternative 2, Alternative 3 would entirely eliminate the small bycatch predicted to occur with the Proposed Action (Alternative 1). Because marine bird bycatch would not occur with Alternative 3, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.1.4 Alternative 4 – No Action/No Authorized Take

Like Alternative 2 or 3, Alternative 4 would preclude all marine-area fisheries. No fishing would occur in any habitat, including habitats occupied by alcids or other seabirds susceptible to gillnet mortality. Therefore, Alternative 4 would have no impact to regional marine bird populations. Like Alternative 2 or 3, this alternative would completely eliminate the small marine bird bycatch that would occur under Alternative 1. Because this bycatch would not occur under Alternative 4, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.2 Marine Mammals

The National Marine Fisheries Service (NMFS) is required under the Marine Mammal Protection Act to periodically reassess each stock of marine mammal species, determine a minimum population estimate, then calculate a Potential Biological Removal (PBR) value. The PBR, unique to each species, is the estimated number of marine mammals that could be killed or seriously injured by human activities without depleting the stock (Barlow et al. 1995). Generally, stock PBRs are 6 percent of the minimum estimated stock size. NMFS is further mandated to regulate fisheries in a manner towards achieving a goal of zero mortality or serious injury to marine mammals. NMFS has proposed ~~considers~~ that fisheries are achieving this goal when the annual mortality of a given marine mammal species is less than 10 percent of the PBR (69 FR 23477). NMFS also annually publishes in the Federal Register a list of all fisheries (Annual List of Fisheries) classifying each as to its potential impact to individual stocks. In the 2003 List of Fisheries (NOAA 2003), Washington beach seine, salmon purse seine, and salmon reef net fisheries were all classified as Category III – no documented marine mammal mortality with potential mortality less than 1 percent of PBR. The Washington Puget Sound Region salmon drift gillnet fishery (excluding treaty fishing) was classified in 1995 as Category II (60 FR 67063) with documented mortality of harbor porpoise, Dall's porpoise, and harbor seal between 1 and 50 percent of PBR. However, ~~NMFS (2000a)~~Carretta et al. (2004) used Laake et al.'s (1997) estimate of 3,509 animals to calculate a minimum population estimate of 2,545 and a PBR of 20 animals for the Washington Inland Waters stock of harbor porpoise. In the 1995 evaluation, NMFS noted that the estimated take of harbor porpoises at the time (15) exceeded 10% of PBR (2.7) and therefore could not be considered insignificant. However, NMFS further reported that the take estimate was derived from observations in the sockeye salmon fishery and included treaty fishing effort, which constitutes about one half of the effort in Puget Sound, but is exempted under the Marine Mammal Protection Act. Therefore the estimated take of harbor porpoise for the non-tribal salmon drift gillnet fishery would be about one half of the total estimated take (7.5), which is greater than one percent but less than 50 percent of the calculated PBR for the stock. Since that time the effort in the fishery has been reduced through license buy back programs and the number of active participants in the non-tribal fishery declined from 1,044 in 1995 to 210 in 2003 (69 FR]. Further, gear modifications and changes to daylight fishing periods for the benefit of endangered seabirds are likely also beneficial for reducing interactions with harbor porpoises. Commercial fishers are required, by regulation, to report incidental marine mammal injuries or deaths to NMFS ~~Then, using Pierce et al.'s (1996) estimate of 15 harbor~~

~~porpoise killed in the 1994 sockeye gillnet fishery, NMFS (2000a) concluded that although the estimated annual mortality (15) did not exceed PBR (20), at 75 percent PBR it was not insignificant nor approaching zero mortality and serious injury rate. Fishermen are currently required by NMFS to provide reports of lethal encounters with Category II marine mammals~~ (personal communication with Brent Norberg, NOAA Fisheries Northwest Region, April 4, 2003). This allows NMFS to monitor the impacts to harbor porpoise in the Puget Sound salmon drift gillnet fishery. If patterns of interactions emerge, this information could be used to shape fisheries to further reduce harbor porpoise-fishing gear interactions.

NMFS (~~NMFS 2000b~~Carretta et al. 2004) has not calculated an annual mortality rate for Dall's porpoise as a result of the Puget Sound salmon fishery. However, the calculated PBR of ~~787~~ 789 for the California/Oregon/ Washington stock (minimum population estimate = 75,915) is sufficiently high that the potential annual mortality is unlikely to exceed 10 percent of the PBR and, therefore, should be approaching a zero mortality or serious injury rate.

~~NMFS (1998)~~Carretta et al. (2004) estimated the minimum population size of the Inland Washington stock of harbor seal at ~~16,104~~ 12,844, and calculated a PBR of ~~966~~ 771 animals. Professing that no reliable estimate of annual mortality incidental to commercial fisheries was available because of a lack of sufficient observer effort, ~~NMFS (1998)~~ Carretta et al. (2004) used available data (Gearin et al. 1994; Pierce et al. 1996; and Erstad et al. 1996), and estimated the annual mortality from all Washington fisheries at ~~36~~ 30 animals, well less than 10 percent of PBR.

Although California sea lions are susceptible to gillnet entanglement, deaths from entanglement in the Puget Sound gillnet fisheries has not been reported (~~NMFS 2000c~~Carretta et al. 2004). This is partially due to the fact that peak abundances of California sea lions in Puget Sound occur in winter and spring after most salmon fisheries are complete (NMFS 1997). California sea lions do interact with tribal gillnet fisheries in terminal areas for winter run steelhead and chum salmon. In order to protect their fisheries, tribal fisherman legally harvest a number of these depredating sea lions under subsistence regulations (personal communication with Will Beattie, Northwest Indian Fisheries Commission, December 19, 2003). These removals, however, are negligible compared to the minimum population estimate of ~~110,000~~ 138,881 for this stock, and it's PBR of ~~6,143~~ 8,333 (~~NMFS 2000c~~Carretta et al. 2004).

NMFS Annual List of Fisheries only classifies commercial fisheries, not sport fisheries. However, Noviello (1999) did study the potential impact of Puget Sound sport fisheries on marine mammals during the 1997 and 1998 seasons. During this study, no marine mammal hook-ups or entanglements were observed in 1,090 hook-up observations, although NMFS and WDFW have received a substantial number of reports of seal and sea lion interations with salmon sport fisheries. These interactions include losses of fish off lines at Neah Bay, Sekiu, Point No Point, Point Defiance, and off the Nisqually River. The sport fishery probably does not represent a ~~potential~~ substantial source of mortality for marine mammals, although anglers do shoot seals and sea lions based on anecdotal reports and observed strandings with bullet wounds (personal communication with Steve Jeffries, WDFW, Research Scientist, July 30, 2004)~~.~~

4.8.2.1 Alternative 1 – Proposed Action/Status Quo

Under Alternative 1, mortality levels of marine mammals as a result of Puget Sound fisheries would likely be similar to those observed during the 1990s, or considerably less if shortened fishing seasons and declines in fishing effort continue. Gillnet fisheries would be expected to result in the incidental ~~capture~~ mortality of small numbers of harbor seals, harbor porpoise, and Dall's porpoise and the removal of California sea lions predating on entangled salmon. Mortality rates would continue to be low compared to stock population levels, however, and management concerns would therefore not be warranted. However, NMFS acknowledges that these mortality rates are based on limited data and that further data is needed for more accurate estimates of mortality rates.

4.8.2.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, no salmon fishing would occur in marine waters, only freshwater rivers except for small-scale, nearshore fisheries in Dungeness Bay (Marine Catch Area 6D), Tulalip Harbor (Marine Catch Area 8D), and adjacent to the Hoodsport Hatchery in Hood Canal (Marine Catch Area 12H); therefore, most of the marine mammals inhabiting Puget Sound would not come in contact with fisheries managed under Alternative 2. Harbor seals and California sea lions would be exceptions, as both commonly enter freshwater rivers (Stanley and Shaffer 1995; and NMFS 1997), and even lakes (Scheffer and Slipp 1948). NMFS (1997) stated that the 2,000 to 3,000 harbor seals ~~annually enter~~in the Columbia River during the winter forage on~~in pursuit of~~ eulochon runs that move upstream to spawn. California sea lions also forage on the eulachon run as it enters the Columbia River; shifting to predation on spring chinook as it becomes more abundant~~, and~~. California sea lions are also commonly observed in the Duwamish, Green, and Nisqually Rivers. Consequently, it is possible for harbor seals and~~,~~ California sea lions to encounter, and possibly become entangled in, gillnets set in terminal river locations. However, there is currently no evidence of harbor seal or sea lion entanglement mortality associated with terminal fisheries in the Strait of Juan de Fuca or Puget Sound region, although this may be due to a lack of observer data and declines in self-reporting. The level of self-reporting after

1995 dropped dramatically, such that the records are considered incomplete and estimates of mortality based on them represent minimums (Carretta et al. 2004). ~~although s~~Some animals are legally harvested in the rivers under tribal subsistence regulations. There have been only a few reported takes of harbor seals from directed tribal subsistence hunts. It is possible that very few seals have been taken in directed hunts because tribal fishers use seals caught incidentally to fishing operations for their subsistence needs before undertaking a ceremonial or subsistence hunt. From communications with the tribes, the NMFS Northwest Regional Office (personal communication with J. Scordino as cited in Carretta et al. 2004) believes that 5-10 harbor seals from this stock may be taken annually in directed subsistence harvests off the Washington coast. Therefore, the combination of harbor seals and sea lions from taken in subsistence fisheries and those potentially caught incidentally in salmon fisheries, as estimated from available data, would be low and ~~se removals do~~would not exceed biological thresholds of concern (greater than 10 percent of PBR). Further data is needed for more accurate estimates of mortality rates.

The increased in-river harvest opportunity available in some areas under Alternative 2, relative to Alternative 1, would result in higher freshwater gillnet fishing effort. The number of vessels involved would increase in some areas, and fishery openings would likely be extended in these areas, relative to Alternative 1. However, such an increase in freshwater fishing, combined with almost no marine-area fishing, would still result in overall lower mortality of harbor seals and sea lions, compared to Alternative 1. Therefore, the potential marine mammal mortality associated with Alternative 2 is likely ~~extremely~~ low for harbor seals and California sea lions, and zero for all other marine mammals. Compared to Alternative 1, Alternative 2 would eliminate any bycatch concerns with harbor porpoise and other cetaceans. Because this bycatch would not occur under Alternative 2, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.2.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Under Alternative 3, gillnet fisheries for salmon would occur at virtually the same times and in virtually the same places as under Alternative 2, so the impacts of gillnet fisheries to marine mammals would be the same. No salmon fishing would occur in marine waters, only freshwater rivers; therefore, the potential marine mammal mortality associated with Alternative 3 is likely ~~extremely~~ low for harbor seals and California sea lions, and zero for all other marine mammals The more restrictive fisheries in Alternative 3 would slightly decrease the potential for interactions with harbor seals (and California sea lions) in particular, relative to Alternative 2. Compared to Alternative 1, Alternative 3 would eliminate any bycatch concerns with harbor porpoise and other cetaceans. Because this bycatch would not occur under Alternative 3, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.2.4 Alternative 4 – No Action/No Authorized Take

Under Alternative 4, no salmon fishing would occur in marine waters. Therefore, Alternative 4 would have no potential for impact to marine mammals, with the exception of a possible extremely low mortality rate for river-inhabiting harbor seals and California sea lions. Like Alternative 2 or 3, Alternative 4 would eliminate all potential incidental take of harbor porpoise and other cetaceans that could possibly occur under Alternative 1.

4.8.3 Marine Invertebrates

Four of the five types of salmon fishing authorized in Puget Sound and the Strait of Juan de Fuca – sport, purse seine, beach seine, reef net, or gillnet – do not actively operate in the benthic zone where marine invertebrates occur. Beach seining is an exception, where a seine net is dragged along the bottom as it is hauled ashore. However, beaching seining generally occurs over sandy or pebbly substrates to avoid snagging on exposed rocks, therefore not occurring where encounters of benthic invertebrates are most likely to occur. Further, captured marine invertebrates (e.g., crabs, sea stars) are easily released unharmed.

The sport fishing "mooching" technique involves bouncing weight and bait along the seafloor. An occasional sea pen, anemone, or sea star is snagged, but all are usually released unharmed. The only invertebrate observed by Noviello (1999) during observation of 1,090 hookups during the 1997 and 1998 Puget Sound sport fishery was a single sea star.

Set gillnets that reach to the seafloor commonly capture crabs as a bycatch, although they are generally released alive. A growing concern, however, involves ghost nets, especially gillnets that have been lost and continue to fish (High 1985). Although not yet quantified, these nets have been observed to continually capture crabs for years (personal communication with Wayne Palsson, Washington Department of Fish and Wildlife, Research Scientist, February 17, 2003). One 575-foot-long net lost in Puget Sound contained an estimated 1,000 female crabs (Breen 1990). During the removal of derelict gear by the Natural Resource Consultants (see Subsections 3.3.5 and 3.8.1), divers reported high sedimentation rates on many of the nets that had apparently suffocated sessile animals on the hard rock substrate. Adjacent areas, without derelict nets, were observed to have a relatively higher density of sessile and bottom dwelling organisms such as sea urchins and sea cucumbers. Several of the nets had rolled into long tubes of webbing and lead line that was entangled on a rock pinnacle or reef edge at one end. The tube of net was observed to sweep back and forth over the gravel seabed in an arc. The divers reported no animals or vegetation on the seabed in the arc swept by these nets. These results are too recent (April 5, 2004) for rigorous estimates of cumulative impacts to populations of fish and benthic organisms to be available.

4.8.3.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action would likely result in no or very low impacts to marine invertebrates as the five types of Puget Sound salmon fishery do not operate on the seafloor in a manner that is lethal to benthic organisms. The only concern identified that requires further investigation is the long-term lethality of derelict nets lost during gillnet fisheries.

4.8.3.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Under Alternative 2, salmon fisheries would occur primarily in rivers. Very limited nearshore, marine-area harvest would occur in Dungeness Bay (Marine Catch Area 6D), Tulalip Harbor (Marine Catch Area 8D), and adjacent to the Hoodsport Hatchery in southern Hood Canal (Marine Catch Area 12H) using beach seines and set gillnets. There would be no measurable impact to marine invertebrates. Compared to Alternative 1, Alternative 2 would eliminate ghost net concerns, except those left by previous fishing activities.

4.8.3.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Under Alternative 3, no salmon fishing would occur in the marine waters of Puget Sound. Consequently, there would be no avenues for impact to marine invertebrates. Compared to Alternative 1, Alternative 3 would eliminate ghost net concerns, except those left by previous fishing activities.

4.8.3.4 Alternative 4 – No Action/No Authorized Take

Like Alternative 2, no salmon fishing would occur in marine waters of Puget Sound or the Strait of Juan de Fuca with Alternative 4; therefore, there would be no mechanisms to potentially impact marine invertebrates. Like Alternative 2, Alternative 4 would eliminate ghost net concerns raised under Alternative 1, except those left by previous fishing activities.

4.8.4 Threatened and Endangered Wildlife Species

Seven threatened and endangered wildlife species are at least occasionally found in the inland marine waters of Washington. These include the marbled murrelet, California brown pelican, bald eagle, Steller sea lion, humpback whale, fin whale, and Pacific leatherback turtle. All, except possibly the bald eagle, have been reported entangled in fishing nets. However, only the marbled murrelet has been reported as a bycatch in the Puget Sound salmon fishery (Pierce et al. 1996; and Melvin et al. 1998).

Further, the total numbers of pelicans, Steller sea lions, humpback whales, fin whales, and leatherback turtles that annually enter Puget Sound are sufficiently small that total mortality of these animals would not exceed 10 percent of stock PBRs.

Salmon, especially runs of fall coho and chum salmon that extend into winter (December-February), are an important food source for hundreds of bald eagles wintering in Washington. However, annual fishing harvest managed for sustainable levels and abundance of fall chum and coho salmon has increased over the last decade. In turn, this management strategy ensures that enough chum and coho salmon return annually to support a viable wintering eagle population.

Carter et al. (1995) expressed concern that marbled murrelet mortality from Puget Sound gillnet fishing was likely substantial, based on extrapolations from the 1979 to 1980 Barkley Sound, British Columbia, murrelet densities and mortality rates. However, Pierce et al. (1996) observed the 1994 sockeye gillnet fishery in Marine Catch Areas 7 and 7A to quantify seabird and marine mammal interactions, and recorded only one murrelet entanglement, in Marine Catch Area 7. This individual was released alive. The entanglement rate was estimated to be 0.00158 per set in Area 7, or 0.00045 per set for the combined Marine Catch Area 7 and 7A fishery. Wide confidence limits were associated with these estimates of entanglement rate. It was estimated based on extrapolation that the 1994 fishery killed 15 birds, and it was concluded that the occurrence of marbled murrelet entanglement in these areas was "an extremely rare event." Melvin et al (1999) conducted an experimental test of a gillnet designed to reduce seabird entanglements, during the 1996 sockeye fishery. They observed one marbled murrelet capture in 642 sets, and categorized the capture as "extremely rare." Both studies suggest that murrelet encounters with fisheries are so rare that sufficient sample sizes are difficult to generate to develop meaningful estimates of mortality. Courtney et al. (1997) surveyed for marbled murrelets in several fishing areas throughout Puget Sound, and concluded that the potential for entanglement was generally localized and unpredictable, with Hood Canal a potential location for future problems. Having observed large flocks of marbled murrelets in northern Hood Canal in the fall, Courtney et al. (1997) noted the potential there for murrelet interactions with gillnet fisheries. Finally, however, observations by Beauchamp et al. (1999) suggest that a portion of the seasonal influx of marbled murrelets into the inland waters of Washington in the fall and winter are breeding birds from British Columbia (rather than the listed U.S. population).

Conclusions from information gathered in the 1990s are that the potential for substantial marbled murrelet mortality from gillnets remains in the Puget Sound region, although actual observation of entanglement events is extremely rare. However, with the current requirements on the non-treaty gillnet fishery in Marine Catch Areas 7 and 7A to utilize nets designed to reduce alcid entanglement, and to preclude fishing during dawn hours when alcids are actively feeding, murrelet mortality rates from the 1990s may be reduced by 70 to 75 percent based on research by Melvin et al. (1999).

4.8.4.1 Alternative 1 – Proposed Action/Status Quo

The Proposed Action would result in gillnet fishing effort in the Strait of Juan de Fuca and Puget Sound similar in area but less intense than that which occurred in the mid-1990s, when studies on marbled murrelet encounters with gillnet fisheries were conducted. These studies (Pierce et al. 1996; and Melvin et al. 1999) failed to show substantial mortality to marbled murrelets from Puget Sound gillnet fisheries then. Mortality is probably greatly ameliorated by the new fishing gear and fishing schedules implemented in the non-treaty fishery, and the shorter fishing season and reduced fishing effort in Marine Catch Areas 7 and 7A typical of recent years in both tribal and non-tribal fisheries. Consequently, there is no evidence that Puget Sound gillnet fisheries as proposed under the Puget Sound Chinook Harvest Resource Management Plan (Alternative 1) would substantially impact local marbled murrelet populations. Past consultations conducted by the U.S. Fish and Wildlife Service (USFWS), pursuant the Endangered Species Act, concluded that Puget Sound fisheries do not jeopardize the continued survival and recovery of the threatened marbled murrelet population. The previous incidental take allowance for treaty tribal salmon fisheries expired in December 2003 (USFWS). The incidental take allowance for Puget Sound non-tribal commercial and sport salmon fisheries extends through 2011 (USFWS 2001). The Puget Sound treaty tribes recently completed a consultation with the USFWS on the effect of fisheries under the Proposed Action on marbled murrelets (USFWS 2004). They specify terms and conditions and conservation measures that are designed to minimize the effects on encounters with live murrelets, minimize the potential to exceed the allowable take and recommend evaluation of alternative salmon harvest methods and fishery implementation to reduce marbled murrelets entanglement and encounters. As described in Subsection 4.8.4, the current requirements to use nets designed to reduce alcid entanglement, and the preclusion of fishing during dawn hours when alcids are actively feeding are example of these types of measures that have been implemented in non-tribal salmon fisheries.

4.8.4.2 Alternative 2 – Escapement Goal Management at the Management Unit Level

Salmon fisheries would primarily be confined to rivers under Alternative 2, so there would be very low risk of entanglement of marbled murrelets, although the harvest opportunity in Tulalip Harbor (Marine Catch Area 8D) possible under Alternative 2 would involve gillnet fishing where aggregations of murrelets have been observed in the fall (Courtney et al. 1997). Alternative 2 would therefore pose a lower risk to marbled murrelets than Alternative 1, though this reduced level of risk cannot be quantified with the available data. Because marbled murrelet bycatch would not occur under Alternative 2, this alternative would be considered to have a beneficial impact when compared to Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.4.3 Alternative 3 – Escapement Goal Management at the Population Level with Terminal Fisheries Only

Under Alternative 3, salmon harvest would be limited to freshwater rivers only. No fishing would occur in marine waters inhabited by marbled murrelets. Therefore, this alternative would have no potential to affect local marbled murrelet populations, and would eliminate the very small bycatch risk posed by Alternative 1. Because this bycatch would not occur under Alternative 3, it would be considered to have a beneficial impact when compared with Alternative 1; however, the magnitude of the beneficial impact is considered low.

4.8.4.4 Alternative 4 – No Action/No Authorized Take

Like Alternative 3, Alternative 4 would result in no harvest in marine waters where marbled murrelets are found. Consequently, this alternative would have no impact on marbled murrelets and, like Alternative 3, would eliminate the very low risk of bycatch posed by Alternative 1.

4.8.5 Wildlife Indirect Effects

Direct mortality of adult seabirds (primarily alcids) indirectly affects the abundance of subsequent breeding populations. Mortality of females could be more significant in this regard. Mortality of juvenile birds can also depress production, but the effect is discounted to the extent juveniles might otherwise die from natural causes before they reach sexual maturity or breed. The age composition (i.e., adults vs. juveniles) of seabirds entangled in Puget Sound fisheries varies among species. A greater proportion of entangled rhinoceros auklets are young-of-the-year, compared to common murres (Thompson et al. 1998), in part due to proximity of auklet colonies to fishing areas. The magnitude of fishery-related mortality of alcids, relative to other natural or human causes has not been quantified. It is known to be highly variable and unpredictable, as is natural mortality. Other known causes of significant mortality include recent oil spills; predation by eagles, gulls, and corvids; and reduction in marine productivity due to the El Nino phenomenon (Manuwal et al. 2001).

Indirect effects at a finer scale (e.g., mortality impacts on sub-populations of common murres or marbled murrelets that breed in Oregon, Washington, or British Columbia), are also possible, and could affect the diversity within species, but these effects are not quantifiable at this time. Thompson et al.

(1998) concluded that common murres from both Oregon and Washington colonies are entangled in Puget Sound fisheries.

The fishing regime envisioned under Alternative 1 would have greater indirect effects on alcid seabirds than Alternative 2, 3 or 4, under which marine-area fisheries with the potential to entangle seabirds would be closed. The currently stable status of common murres and rhinoceros auklets suggests that these species are resilient to the cumulative effects of human-caused and natural mortality. The threatened status of marbled murrelets in Washington warrants higher concern over all sources of mortality. But the best available information (Pierce et al 1994; and Melvin et al 2001) indicates that entanglement in gillnet fisheries occurs very rarely, so it is difficult to conclude that eliminating this source of mortality would have any measurable beneficial effect, given the relatively greater constraints imposed by habitat and natural predation.

Because of their indirect effect on the abundance of juvenile salmon in subsequent years, the Proposed Action or alternatives imply some potential for altering the food supply of piscivorous seabirds. The alternatives to the Proposed Action (Alternative 1), particularly Alternative 4, would result in higher spawning escapement of salmon. It is not certain, however, that substantially higher escapement will, in the long term, necessarily result in higher production of juvenile salmon. Nor is there information available to support the contention that the current abundance of juvenile salmonids constrains the survival of any seabird species, or that secondary productivity in Puget Sound constrains survival of juvenile salmonids or seabirds. So it is not possible to speculate that increasing the abundance of juvenile salmonids would have a measurable positive effect on predators, or negative effect on competition. Increasing the escapement of adult salmon to the degree projected under Alternatives 2, 3, or 4 would, for some period through the fall and winter, increase the food supply for a wide variety of vertebrate species known to utilize this resource (Cederholm et al. 1999). The accumulation of carcasses and material in the lower reaches of streams generates a seasonal pulse of nutrients to estuarine and nearshore marine areas, with potential indirect benefit to many other fish and invertebrate species. Uptake and transport of these nutrients through the food chain would occur over subsequent years. Though carcass enhancement has been experimentally shown to increase local primary and secondary production, and enable higher growth rates among juvenile salmon and other resident salmonids (discussed in Subsection 3.3.6, Marine-Derived Nutrients from Salmon Spawners – Affected Environment), information is lacking to quantify the long-term direct or indirect effects on communities or individual species.

The indirect effects of higher juvenile salmon abundance, were that to occur as a consequence of Alternatives 2, 3, or 4, on the abundance of other fish and invertebrate species, much less their avian or mammalian predators, cannot be predicted with any certainty. Intuitively, any increases in subadult or adult salmon could increase predation on forage fish species such as Pacific herring, smelt, and sandlance. This effect would be pronounced during periods when migrating salmon are at highest density in Puget Sound (i.e., as they migrate toward the outer coast and as they return to spawn); however, adult salmon feed less frequently as they approach maturity and enter fresh water. The potential for competition with other species that also utilize these species would exist during these periods. Though production of these forage species is depressed in Puget Sound, there is no information to support a conclusion that their current productivity now constrains the growth and survival of their predators, or would do so at higher predator abundance.

The reduction of net fisheries as contemplated under Alternative 2, 3, or 4 would reduce the rate of potential gear loss in Puget Sound. Some nets that are lost in Puget Sound fisheries, especially gillnets, continue to fish, entangling marine mammals, marine birds, and invertebrates such as crabs (High 1985, and Breen 1990). The influence of these ghost nets on the mortality rate of any given species, however, is presently unknown, and may not be significant. Nevertheless, there is enough concern that concerted efforts are presently being undertaken by the Northwest Straits Commission and Washington Department of Fish and Wildlife to remove tons of these derelict nets from the Puget Sound ecosystem (Derelict Fishing Gear Removal Project).

Because salmon may contribute a large proportion of the diet of southern resident killer whales (Ford et al. 1998), fisheries that reduce the abundance of adult salmon in Puget Sound may indirectly impact this species. This hypothesis is based on the as-yet-undemonstrated assumption that the current total abundance of salmon, including hatchery production, that rear or migrate through Puget Sound, is significantly lower or has declined in coincidence with the observed decline in the abundance of southern resident killer whales. In evaluating the status of killer whales, Krahn et al. (2002) did not conclude that prey availability affected southern resident killer whales. However, in the absence of marine-area fisheries, particularly as envisioned under Alternatives 2, 3, or 4, the increase in availability of salmon could have beneficial effects on killer whales by increasing local prey availability.

Cederholm et al. (2001) identified nine wildlife species with strong consistent links to salmon. Mergansers and harlequin ducks feed on drift eggs, Caspian terns and osprey on freshwater juveniles, bald eagles on saltwater subadults and carcasses, killer whales on saltwater adults, and bears and river otters on spawning adults and carcasses. Cederholm et al. (1989) found black bears on the Olympic Peninsula to forage heavily on salmon carcasses, much like black bears in western Canada and Alaska. However, most bear diet studies in Washington show a consistent lack of black bear use of salmon (Cederholm et al. 2001). Stable isotope studies by Hildebrand et al. (1996) suggested that grizzly bears inhabiting the Columbia Basin prior to European settlement foraged heavily on the large salmon runs that occurred then. Only about 5-20 grizzly bears now occur in Washington (North Cascades) and the importance of salmon to their diet is unknown. Nevertheless, all nine species strongly linked to salmon could potentially benefit from increased salmon production in the river tributaries of Puget Sound, although the benefit is not quantifiable.

4.8.6 Cumulative Effects on Wildlife

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR1508.7)." For the purposes of this discussion, the terms "effects" and "impacts" will be considered synonymously with "consequences," and consequences may be negative or beneficial. This section presents an analysis of the cumulative effects (negative or beneficial) of the Proposed Action in the context of other local, state, tribal, and federal management activities in the Puget Sound region on fish resources and related economic conditions.

The geographic scope of the cumulative effects analysis area includes the entire Puget Sound region. The analysis area covers both inland and marine environments that are managed under laws, policies, regulations, and plans having a direct or indirect impact on fish. The substantive scope of the cumulative analysis is predicated on a review of laws, policies, regulations, and plans that specifically pertain to fish-related management activities or that have an indirect negative or beneficial effect on fish resources and related economic conditions. These laws, policies, regulations, and plans are described in Section 1 and Appendix F. Because of the geographic scope of the analysis area, it is not feasible to analyze all habitat-specific activities that are occurring, have occurred in the past, or that will occur in the future in a quantitative manner. By reviewing laws, policies, regulations, and plans, the analysis will capture the objectives of any management activity that is occurring or planned to occur that may interface with fish resources within the Puget Sound region. It is assumed that no management activity is occurring or would occur outside of an implemented law, policy, regulation, or sanctioned plan at the federal, tribal, state, or local level. Although the analysis is necessarily qualitative, it provides a thorough review of all other activities within the region that, when combined with the Proposed Action, could have a negative or beneficial affect on fish resources and related economic conditions.

Table 4.3.8.2-1 summarizes the potential cumulative effects on fish resources of implementing the Proposed Action with the effects of these existing laws, policies, regulations, and plans. The table below summarizes the potential cumulative effects on wildlife of the Proposed Action and other plans, policies and programs in the Puget Sound region.

The Proposed Action is implementation of the Puget Sound Chinook Harvest Resource Management Plan (RMP), jointly prepared by the Washington Department of Fish and Wildlife (WDFW) and the Puget Sound Treaty Tribes (co-managers). Factors common to the relationship between the RMP and the various existing plans, policies and programs include: 1) the Resource Management Plan would provide protection to Puget Sound chinook salmon by conserving the productivity, abundance, and diversity of populations within the Puget Sound Chinook Evolutionarily Significant Unit (ESU), while managing harvest of strong salmon stocks; and 2) conserving productivity requires biological integrity in the freshwater systems in which salmon spawn and rear.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws.

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Fish and Wildlife Coordination Act, 1956, as amended in 1964 (FWCA).	The FWCA recognizes "the vital contribution of our wildlife resources to the Nation, the increasing public interest and significance thereof due to expansion of our national economy and other factors, and to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation."	The Puget Sound Chinook Salmon Resource Management Plan would allow the harvest of salmon in coordination with ongoing conservation and rehabilitation efforts for chinook salmon. With an estimated value of $35 million ($16.2 million commercial plus $18.8 million recreational), the Puget Sound fishing industries are important to the Nation's economy. The Proposed Action would be consistent with the FWCA by recognizing the vital contribution of Puget Sound chinook salmon and local wildlife populations to the Nation and our national economy. It is predicted that implementation of the Resource Management Plan, in combination with the FWCA, would strive to balance considerations of the national economy, while also providing for fish and wildlife conservation.
Washington State Shoreline Management Act of 1971 (SMA).	The SMA was adopted in Washington in 1972 with the goal of "prevent[ing] the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The provisions of this law are designed to guide the development of the shoreline lands in a manner that will promote and enhance the public interest. The law expresses the public concern for protection against adverse effects to public health, the land and its vegetation and wildlife, and the aquatic life of the waters.	Rearing habitat within shoreline areas of Washington State is essential to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the SMA by ensuring that harvest works in concert with habitat protection efforts under the SMA. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the SMA, would protect fish from adverse effects associated with uncoordinated and piecemeal development of the state's shorelines. Puget Sound marine shorelines are also critical nesting and foraging habitat for bald eagles, and nearshore shallow-water areas are used by a variety of seabirds, including marbled murrelets. As with fish, implementation of the Resource Management Plan in combination with the SMA is predicted to aid in the protection of wildlife (e.g., reduced entanglement risk) and their nearshore breeding and foraging habitat.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
The National Marine Sanctuaries Act. Also known as Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA).	The MPRSA authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or a aesthetic qualities as National Marine Sanctuaries. One of the purposes and policies of the MPRSA is "to maintain the natural biological communities in the national marine sanctuaries, and to protect, and, where appropriate, restore and enhance natural habitats, populations, and ecological processes."	Protecting the marine environment where chinook salmon mature is important to conserving the productivity of Puget Sound chinook salmon. Consequently, the Proposed Action would be consistent with the MPRSA by maintaining chinook salmon populations of the natural biological communities in the marine environment. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the MPRSA, would strive to restore and enhance natural habitats, populations, and ecological processes of fish. Marine Sanctuaries also provide protection for many species of marine mammals and seabirds that seasonally use Puget Sound. Those that forage on salmon, or are susceptible to net entanglement, are predicted to further benefit from implementation of the Resource Management Plan.
Coastal Zone Management Act of 1972 (CZMA), as amended through The Coastal Zone Protection Act of 1996.	The CZMA declares a national policy "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations by "the protection of natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone."	Chinook salmon are one of the Nation's resources within the coastal zone regulated by the CZMA. The Proposed Action would be consistent with the CZMA by encouraging preservation and protection of Puget Sound chinook salmon and their habitat within the coastal zone for existing and succeeding generations, and by ensuring that harvest is consistent with the production and capacity of the habitat. Accordingly, it is predicted that implementation of the Resource Management Plan, in combination with the CZMA, would preserve, protect, restore or enhance the fish resources of the Nation's coastal zone. The coastal zone is also important to many species of marine wildlife, including marbled murrelets and bald eagles. The CZMA in combination with the Proposed Action is predicted to benefit marbled murrelets and other seabirds through habitat protection and reduced net entanglement risk, and increased fish prey in the case of bald eagles and other fish-eating predators/scavengers.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Marine Mammal Protection Act of 1972, as amended through 1996 (MMPA).	The MMPA establishes a Federal responsibility to conserve marine mammals, with management vested in the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) for cetaceans and pinnipeds other than walrus. The MMPA states that the "Secretary must undertake a program of research and development for improving fishing methods and gear to reduce to the maximum extent practical the incidental taking of marine mammals in commercial fishing." To meet this requirement, the "Secretary must issue regulations to reduce to the lowest practical level the taking of marine mammals incidental to commercial fishing operations." The Secretary of Commerce has issued regulations that prohibit deterrent devices that might seriously injure or kill a marine mammal, and that require fishermen to report unintentional marine mammal mortality.	The Proposed Action would be consistent with the MMPA to conserve marine mammals because the fisheries would be in compliance with Department of Commerce regulations to reduce to the lowest practical level the take of marine mammals incidental to commercial fishing operations. Although not specifically addressed in the Proposed Action, Department of Commerce regulations require Puget Sound fishermen to use non-lethal deterrent devices and to report unintentional marine mammal mortality. As chinook salmon are prey of marine mammals, implementation of the Proposed Action, in combination with the MMPA, will aid in the maintenance and recovery of marine mammal populations by ensuring that enough fish escape to produce more in subsequent generations as habitat improves.
The Endangered Species Act of 1973, as amended through December, 1996 (ESA).	The purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species…" On July 10, 2000, NMFS issued a rule under section 4(d) of the ESA (referred hereafter as the 4(d) Rule). The 4(d) Rule provided limits on the application of the take prohibitions; i.e., take prohibitions would not apply to the plans and activities set forth in the rule if those plans and activities adequately address criteria of the rule, including that implementation and enforcement of the resource management plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs.	The Puget Sound Chinook Salmon ESU is listed as threatened under the ESA. The Proposed Action to implement the Puget Sound Chinook Salmon Resource Management Plan includes a condition that the Secretary of Commerce will determine whether that the Resource Management Plan adequately addresses the criteria outlined in Limit 6 of the ESA 4(d) Rule. Consequently, the Proposed Action would be consistent with the ESA by meeting these criteria designed to foster goals and objectives of the ESA, including to avoid appreciably reducing the likelihood of survival and recovery of Puget Sound Chinook Salmon ESU. The ESA would not only have a beneficial impact to listed Puget Sound chinook salmon, but species listed under the ESA also include predators of chinook salmon such as bull trout and bald eagles. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the ESA, would potentially have both unquantifiable beneficial and adverse impacts to fish resources and listed wildlife species such as bald eagles that forage on fish.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Habitat Conservation Plans	Section 10 of the Endangered Species Act requires that Habitat Conservation Plans be developed and implemented as a condition of the incidental take permit process. These plans define the impacts of a proposed action on listed species, and the steps an applicant intends to take to minimize and mitigate these impacts.	Listed species inhabiting Puget Sound for which habitat conservation plans have been developed include the marbled murrelet (seven plans) and the bald eagle (six plans). All of these plans involve preserving forest habitat for these species in the general Puget Sound basin. By reducing mortality risks (net entanglement) to marbled murrelets and enhancing the foraging base for bald eagles, implementation of the Proposed Action in combination with the conservation goals of HCPs will benefit marbled murrelets. The HCPs in question are: Cedar River Watershed City of Tacoma, Tacoma Water Plum Creek Timber I-90 Port Blakely RB Eddy Tree Farm Simpson Timber NW Operations Washington DNR Forest Lands West Fork Timber (formerly Murray Pacific).
ESA Recovery Plans	The 1982 and 1988 amendments to the Endangered Species Act of 1973 require that recovery plans be developed and implemented to promote the conservation of listed species.	Recovery plans have been developed for the seven threatened and endangered wildlife species (Pacific leatherback turtle, marbled murrelet, bald eagle, California brown pelican, Steller sea lion, humpback whale, and fin whale) that at least occasionally inhabit Puget Sound. Implementation of the Proposed Action would likely reduce net entanglement risks for those species that potentially interact with the Puget Sound fisheries (the turtle, seabirds, and marine mammals), and benefit those listed species that forage on salmon (bald eagles and Steller sea lions). Thus, implementation of the Proposed Action in combination with the implementation of actions in the recovery plans should benefit these listed species.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
The Clean Water Act, 1977 (CWA). A 1977 amendment to the Federal Water Pollution Control Act (FWPCA) was titled "The Clean Water Act."	The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. As stated in the CWA, maintaining or restoring water quality "provides for the protection and propagation of fish, shellfish, and wildlife…"	Primarily because the CWA would maintain water quality that provides for the protection and propagation of fish, it is predicted that implementation of the Proposed Action, in combination with the CWA, would have a net beneficial impact on fish resources. These benefits would also accrue to the wildlife species that forage on these fish.
The Migratory Bird Treaty Act	The MBTA "absolutely forbids killing, possessing, or trading in migratory birds except in accordance with regulations prescribed by the Secretary of the Interior."	By reducing the risks of net entanglement to migratory seabirds such as murrelets, auklets, and murres, the Proposed Action in combination with the MBTA is predicted to benefit migratory birds.
The Bald Eagle and Golden Eagle Protection Act	This legislation was first enacted in 1940 to protect bald eagles by prohibiting the take, sale, or purchase of these birds. Today, it provides a third level of protection for bald eagles along with the ESA and the MBTA.	Implementation of the Proposed Action is predicted to benefit bald eagles by increasing the available fish resources on which they forage. Consequently, the Proposed Action in combination with the Bald Eagle and Golden Eagle Protection Act is predicted to benefit bald eagles.
The Treaty between the Government of Canada and the Government of the United States of America concerning Pacific Salmon, 1985, including 1999 revised annexes (Pacific Salmon Treaty).	The Pacific Salmon Treaty calls on the U.S. and Canada (Parties) to conduct its fisheries in a manner to "prevent overfishing and provide for optimum production." The Pacific Salmon Treaty defines "overfishing" as "fishing patterns which result in escapements significantly less than those required to produce maximum sustainable yields [MSY]." Annex IV, Chapter 3, Chinook Salmon of the Pacific Salmon Treaty further states that the Parties shall establish a chinook salmon management program that "sustains healthy stocks and rebuilds stocks that have yet to achieve MSY or other biologically-based escapement objectives." Salmon subject to the Pacific Salmon Treaty include Pacific salmon stocks that originate in the waters of one Party and subject to interception by the other Party.	Puget Sound chinook salmon are intercepted in Canadian fisheries under the authority of the Pacific Salmon Treaty. The Proposed Action accounts for all sources of fishery-related chinook salmon mortality, including mortality related to Canadian fisheries. Although the Proposed Action would allow exploitation rates that would result in escapements less than those required to produce maximum sustainable yields in some years, it would, overall, sustain healthy populations and rebuild stocks toward maximum sustainable yield. Consequently, the Proposed Action would be consistent with the Pacific Salmon Treaty. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the Pacific Salmon Treaty, would have a net beneficial impact on the wildlife species that forage on these fish.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl, commonly referred to as the Northwest Forest Plan (NFP), 1994.	The NFP is an integrated, comprehensive design for ecosystem management, intergovernmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. The management direction of the NFP consists of extensive standards and guidelines, including land allocations that comprise a comprehensive ecosystem management strategy. Aquatic conservation strategy objectives outlined in the NFP (Attachment A of the NFP) include, but are not limited to: "Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted;" and, "Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities."	The Proposed Action would be consistent with the intent of NFP to maintain and restore the distribution, diversity, and complexity of watersheds. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the NFP, would have a net beneficial impact on fish resources. Implementation of the NFP also benefits wildlife species such as marbled murrelets (protecting forest breeding habitat), and bald eagles (protecting both breeding and foraging habitat). Together, implementation of the NFP and Proposed Action are predicted to benefit marbled murrelets and bald eagles.
Gravel to Gravel, Regional Salmon Recovery Policy for the Puget Sound and the Coast of Washington, Western Washington Treaty Tribes, July 25, 1997 (Gravel to Gravel Policy).	Major elements of the Gravel to Gravel Policy are to provide habitat protection and restoration, ensuring abundant spawners, managing fisheries, and integrating hatchery production.	The Proposed Action would be consistent with the Gravel to Gravel policy of managing fisheries to ensure abundant spawners. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the Gravel to Gravel Policy, would have a beneficial impact on fish resources, which in turn would benefit wildlife species that forage on these fish.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
Policy of Washington Department of Fish and Wildlife and Western Washington Treaty Tribes Concerning Wild Salmonids (Wild Salmon Policy). Adopted by Washington Fish and Wildlife Commission on December 5, 1997. (Despite the title, the tribal governments have not adopted this Wild Salmon Policy.)	The stated goals of the Wild Salmon Policy include restoring Washington stocks of wild salmon and steelhead to healthy, harvestable runs by "managing commercial and sport fishing to ensure enough wild runs return to spawn while providing fishing opportunities where possible."	The Proposed Action would be consistent with the intent of the Wild Salmon Policy to manage commercial and recreational fishing in a manner that ensures enough wild salmon return to spawn while providing fishing opportunities where possible. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the Wild Salmon Policy, would have a beneficial impact on fish resources, and the wildlife species that forage on these fish.
Statewide Strategy to Recover Salmon, September 21, 1999 (SSRS).	The goal of the SSRS is to "[r]estore salmon, steelhead, and trout populations to healthy and harvestable levels and improve the habitats on which fish rely." The SSRS is the long-term vision or guide for salmon recovery within the State of Washington.	The Proposed Action would be consistent with the intent of SSRS to restore salmon populations to healthy and harvestable levels. Accordingly, it is predicted that implementation of the Proposed Action, in combination with the SSRS, would have a beneficial impact on fish resources, and the wildlife species that forage on these fish.
Local Plans, Policies, and Programs	Local activities that influence cumulative effects to fish include, but are not limited to: Water Supply Projects: Local water departments operate and maintain water reservoirs, pump stations, and water mains to deliver potable water to their customers. Local projects have minimized the adverse impacts of water withdrawal by installing additional water gauges to monitor flows and regulate water use, reducing water intake during critical environmental periods, and by purchasing existing water rights to return water to the system. Levee Maintenance: A levee is a natural or manmade structure, usually an earthen berm or riprap, that parallels the course of a river. It functions to prevent flooding of the adjoining countryside. However, it also confines the flow of the river resulting in deeper, faster flows. In recent years, local levee maintenance projects have included setting back or removing levees. Stormwater Management: Surface water runoff results from rainfall or	Many of these local activities are conducted in cooperation with federal, tribal, and state actions. The fisheries that would be allowed by the Proposed Action are predicted to have minimal to negligible effect on Washington State water quality. Because many of these local plans, policies, and programs would maintain water quality that provides for the protection and propagation of fish, it is predicted that implementation of the Proposed Action, in combination with local plans, policies, and programs, would have a net beneficial impact on fish resources, and the wildlife that feed on these fish.

Table 4.8.6-1 Cumulative effects on wildlife of the Proposed Action in combination with various plans, policies and laws. *continued*

Federal/Tribal/State/Local		
Plans, Policies, and Programs (in chronological order of the earliest to the most recent)	**Description and Intent**	**Cumulative Effect when Combined with the Proposed Action**
	snow melt that does not infiltrate the ground or evaporate due to impervious surfaces. Instead, this runoff flows onto adjacent land, or into watercourses, or is routed into storm drainage collection systems managed by local entities. Local cities and counties are in the process of developing watershed plans, subbasin plans, and revising codes to minimize the adverse impacts of surface water runoff. Wastewater Treatment Projects: Municipal wastewater treatment plants process domestic sewage, and commercial and industrial wastewaters. Stormwater and groundwater infiltration may also enter wastewater treatment plants, though efforts are being made to segregate these flows. Local cities and counties are in the process of developing Facilities Plans and revising codes to minimize adverse impacts associated with wastewater treatment projects. Salmon Recovery Efforts: Local communities are undertaking activities to protect listed species and their habitat. Examples of activities conducted include, but are not limited to: reducing barriers to fish passage; improving habitat forming processes; increasing channel diversity; improving estuarine habitat; and enhancing streamside vegetation. Watershed Conservation Plans: As mandated by the 1998 State of Washington Watershed Management Act and Salmon Recovery Planning Act, counties are conducting watershed planning to address water quality, water quantity, and salmon habitat issues. Bald Eagle Management Plans: In 1984, the Washington State Legislature enacted laws to protect bald eagle habitat through WDFW management processes. From these laws, bald eagle protection rules were developed, requiring site-specific bald eagle management plans be developed where landowner-proposed activities may adversely impact bald eagle habitat. Since 1987, more than 1,150 plans have been developed, the majority in the Puget Sound region.	

4.9 Ownership and Land Use – Parks and Recreation

Activities under the Proposed Action or the alternatives considered are projected to have no perceptible adverse or beneficial effect on land ownership, land use, or designated recreational areas within the Puget Sound Action Area. Current trends in land use would continue under any alternative selected. Construction activities directly related to salmon fisheries during the duration of this action (the ~~2004~~ 2005–2009 fishing seasons) would likely be limited to maintenance and repair of existing facilities, not expected to result in additional impacts to riparian habitats associated with the fisheries regulated by the resource management plan.

Growth or decline in an economy is typically the propulsive force for land use changes. The probable economic consequences of the Proposed Action or alternatives would likely be too small to affect land use (see Subsection 4.6).

Facilities used in association with river fisheries are essentially all in place. If there is a reduction in the salmon fishery program, some access points to the water might experience a reduction in traffic, but in most cases would continue to be used for other river activities, such as recreational boating.

4.10 Water Quality

The Proposed Action or alternatives are not expected to differ significantly in their potential impacts to water quality since, in general, fishing activity has only a limited impact on water quality compared to the myriad of other sources of pollutant inputs to Puget Sound. Most pollutant sources affecting Puget Sound are land-based, as previously described in Subsection 3.10 (Puget Sound Water Quality Action Team 2002). While quantitative estimates of vessel traffic and pollution due to vessel activity are not available, the large number of potential land-based sources and their impact to water quality significantly exceeds potential variation in vessel activity that would result from differences between the Puget Sound Chinook Harvest Resource Management Plan and other fishing regime alternatives under consideration.

Most vessels are used for more than salmon fishing activity. This is probably most true for sport fishing vessels rather than for commercial fishing vessels, but the majority of fishing vessel activity within the Puget Sound Action Area is related to sport fishing. Both sport and commercial fishing vessels are used to harvest other resources (such as, shrimp, herring, crab, rock fish, and shellfish), and smaller vessels are used for other leisure activities (like family trips, diving, pleasure cruising, and water skiing). Although the reductions in angler trips predicted to result from Alternatives 2, 3 or 4 may result in a decrease in vessel traffic in some areas, the reduction is likely to be low or immeasurable given the alternative uses available for these vessels.

4.10.1 Sedimentation and Turbidity

Neither the Proposed Action nor the alternatives considered are predicted to have a measurable adverse or beneficial impact on the levels of sedimentation or turbidity in Puget Sound. No impact is expected. Also, no indirect, cumulative, or long-term impacts are expected to occur.

4.10.2 Non-Point Source Pollution

Neither the Proposed Action nor the alternatives considered are predicted to have a measurable adverse or beneficial impact on the level of non-point source pollution in Puget Sound. No impact is expected. Similarly, no indirect, cumulative, or long-term impacts are expected to occur.